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AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

1 OF 7
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(2) LEVEL III

REPORT SAMSO-TR-77-184

& A062051
VOL I

FINAL REPORT
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY

VOLUME II

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B

Prepared by
J. A. Durschinger
TRW, Inc.
TRW Defense and Space Systems Group
One Space Park
Redondo Beach, CA 90278

Report No. 28600-AR-015-01

Revision A

11 August 1978

APPROVED FOR PUBLIC RELEASE:
DISTRIBUTION UNLIMITED

Prepared for
SPACE AND MISSILE SYSTEMS ORGANIZATION
AIR FORCE SYSTEMS COMMAND
Los Angeles Air Force Station
P. O. Box 92960, Worldway Postal Center
Los Angeles, Calif. 90009

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Captain G. D. Nordley, SAMSO/SKT, was the Project Officer for Space Communicatons Systems.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

JAMES E. FREYTAG, Col, USAF
System Program Director, DSCS
Deputy for Space Comm Systems

ROY B. FREEMAN, Lt Col, USAF
Director of Test & Operations
Deputy for Space Comm Systems

FOR THE COMMANDER

FORREST S. McCARTNEY
Brig General, USAF
Deputy for Space Comm Systems

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High Level Traveling Wave Tube Amplifier (HLTWTA)
DSCS-II, Satellite 9438

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The results of an investigation into orbit failures of HLTWTA on DSCS-II satellite are presented along with recommendation for corrections on future TWTAs to be issued on DSCS-II. The possible causes of these failures are examined in light of orbit data, and laboratory simulation testing.

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9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY

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REPORT SAMSO-TR-77-184

FINAL REPORT

9438 LOW LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY

28600-AR-016-01

REVISION A

11 AUGUST 1978

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DDC Buff Section ☐
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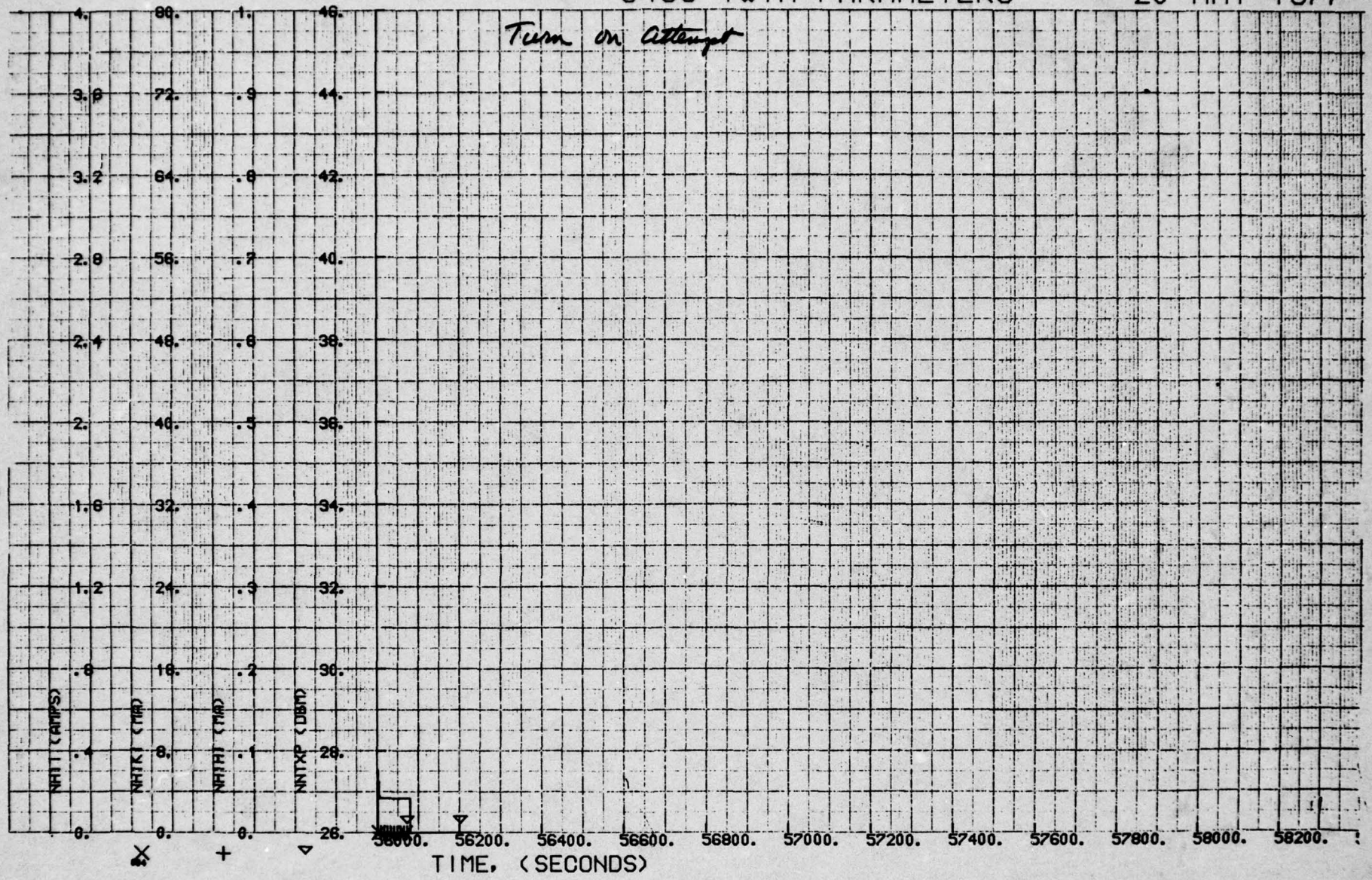
F8 HLTWTA-1 ATTEMPTED RESTARTS ON 20 AND 21 MAY AFTER INITIAL FAILURE

9438 TWTA PARAMETERS 20 MAY 1977



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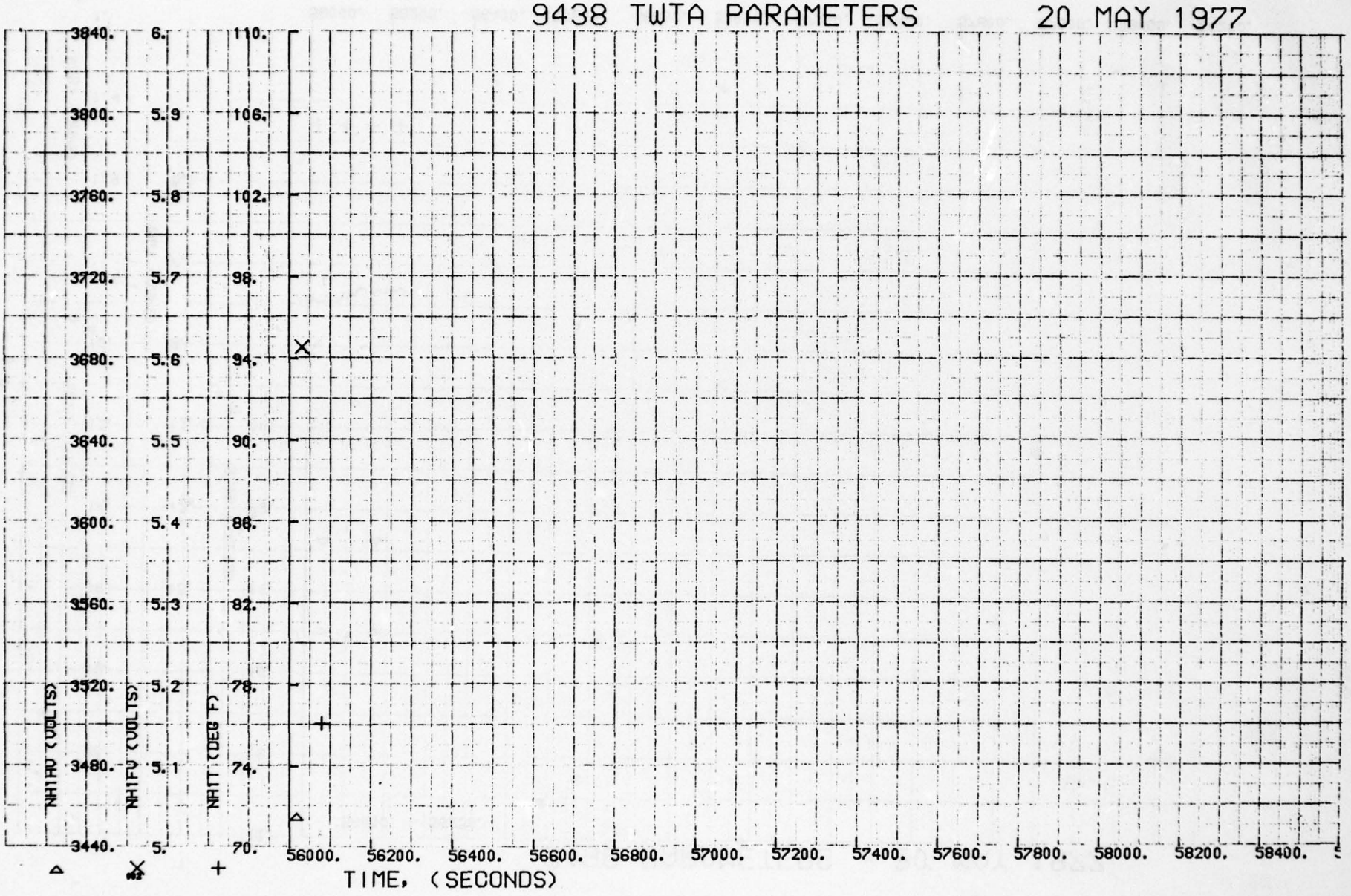
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20 MAY 1977
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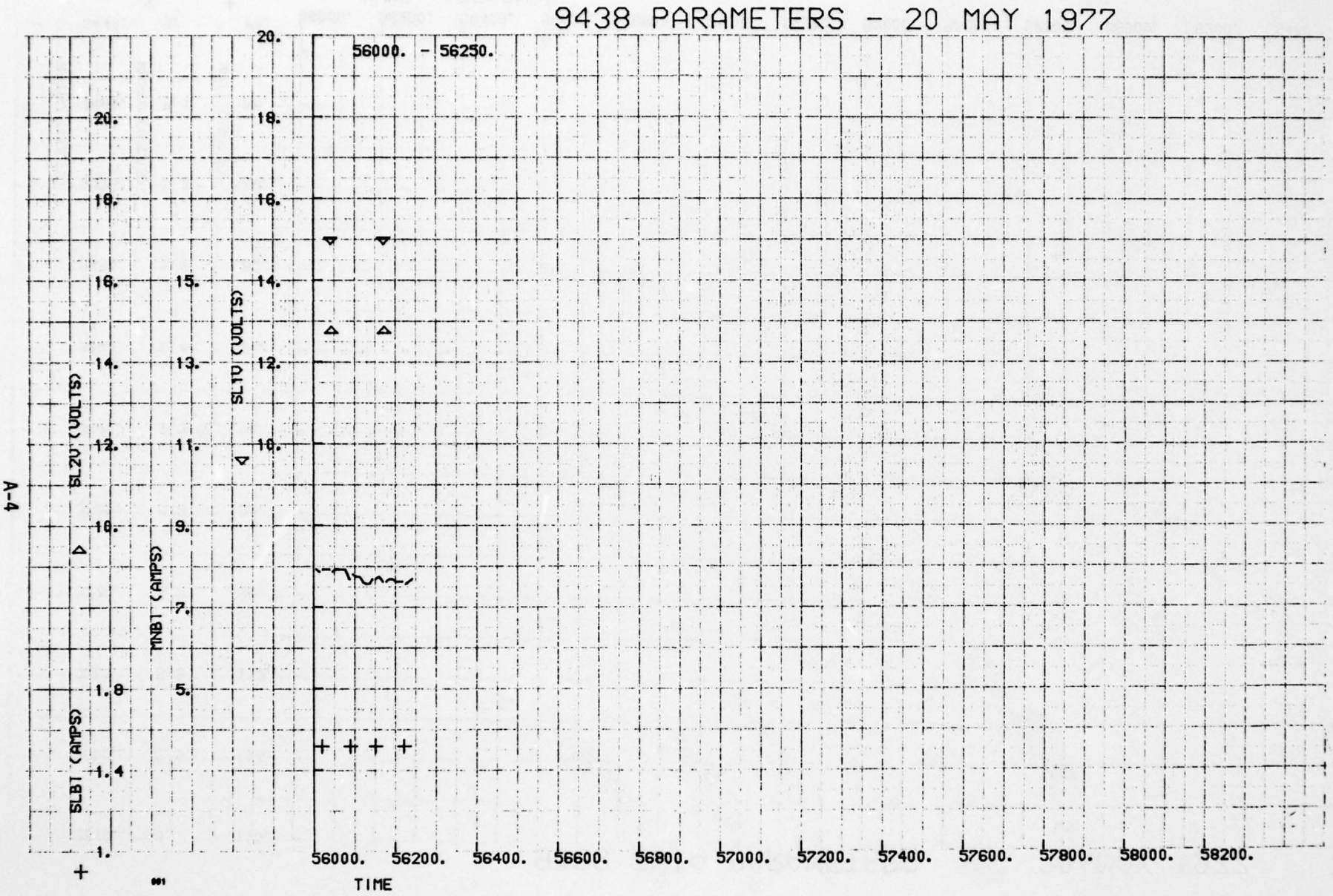
3800.
3760.
3720.
3680.
3640.
3600.
3560.
3520.
3480.
3440.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
NH1HV (VOLTS)
NH1FV (VOLTS)
NH1T (DEG F)
56000.
56200.
56400.
56600.
56800.
57000.
57200.
57400.
57600.
57800.
58000.
58200.
58400.
TIME, (SECONDS)


9438 PARAMETERS - 20 MAY 1977
56000. - 56250.
SL2V (VOLTS)
SL1V (VOLTS)
MNBI (AMPS)
SLBI (AMPS)
TIME
56000.
56200.
56400.
56600.
56800.
57000.
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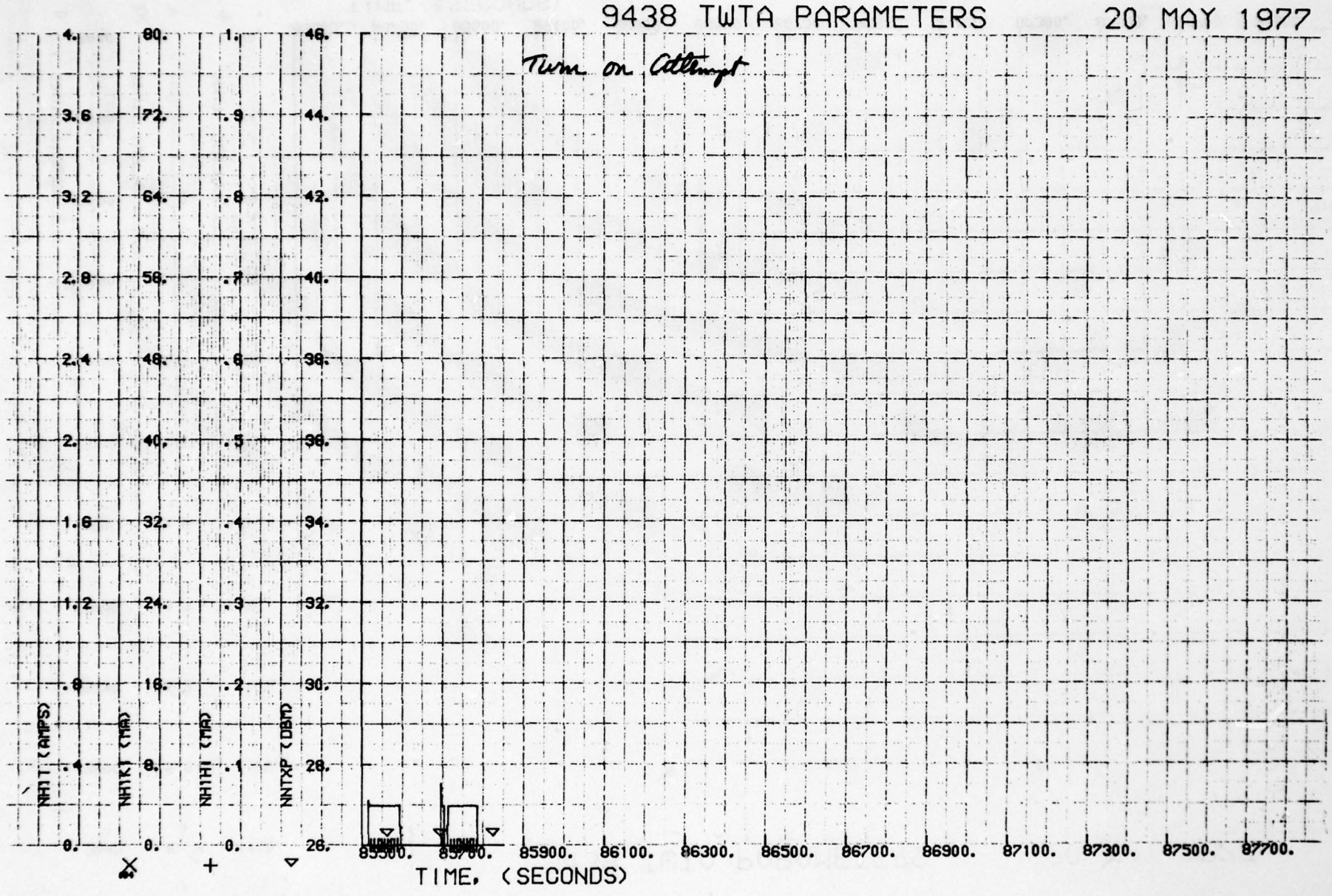
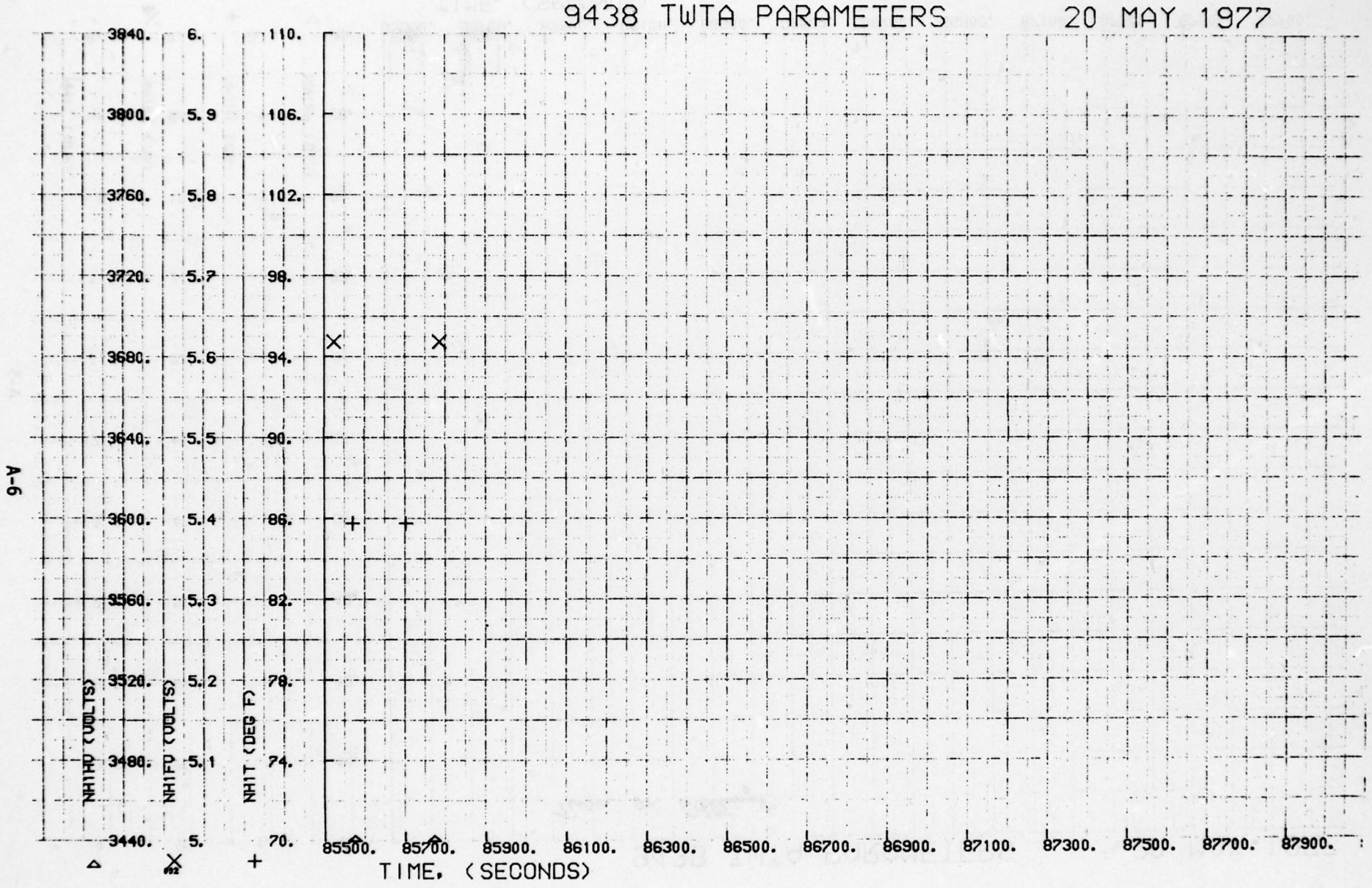
57600.
57800.
58000.
58200.


9438 TWTA PARAMETERS
20 MAY 1977
Turn on Attempt
NH1T (AMPS)
NH1K (MA)
NH1HI (MA)
NNTXP (DBM)
4.
3.6
3.2
2.8
2.4
2.
1.6
1.2
.8
.4
0.
80.
72.
64.
56.
48.
40.
32.
24.
16.
8.
0.
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.
46.
44.
42.
40.
38.
36.
34.
32.
30.
28.
26.
85500.
85700.
85900.
86100.
86300.
86500.
86700.
86900.
87100.
87300.
87500.
87700.
TIME, (SECONDS)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20 MAY 1977
3840.
3800.
3760.
3720.
3680.
3640.
3600.
3560.
3520.
3480.
3440.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
NH1HD (VOLTS)
NH1FD (VOLTS)
NH1T (DEG F)
85500.
85700.
85900.
86100.
86300.
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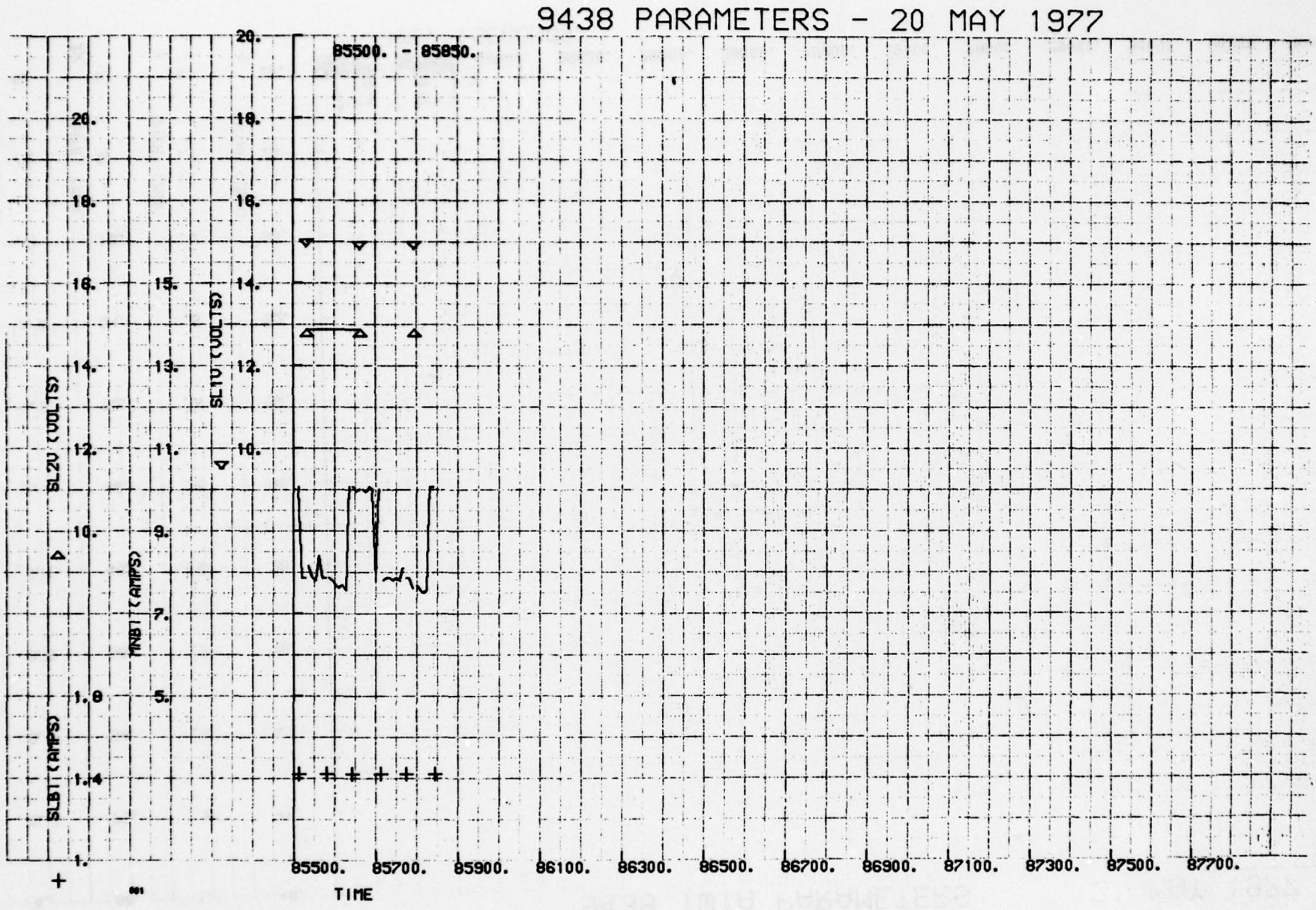
86700.
86900.
87100.
87300.
87500.
87700.
87900.
TIME, (SECONDS)


9438 PARAMETERS - 20 MAY 1977
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SL2V (VOLTS)
SL1V (VOLTS)
SLBI (AMPS)
MNBI (AMPS)
TIME
85500.
85700.
85900.
86100.
86300.
86500.
86700.
86900.
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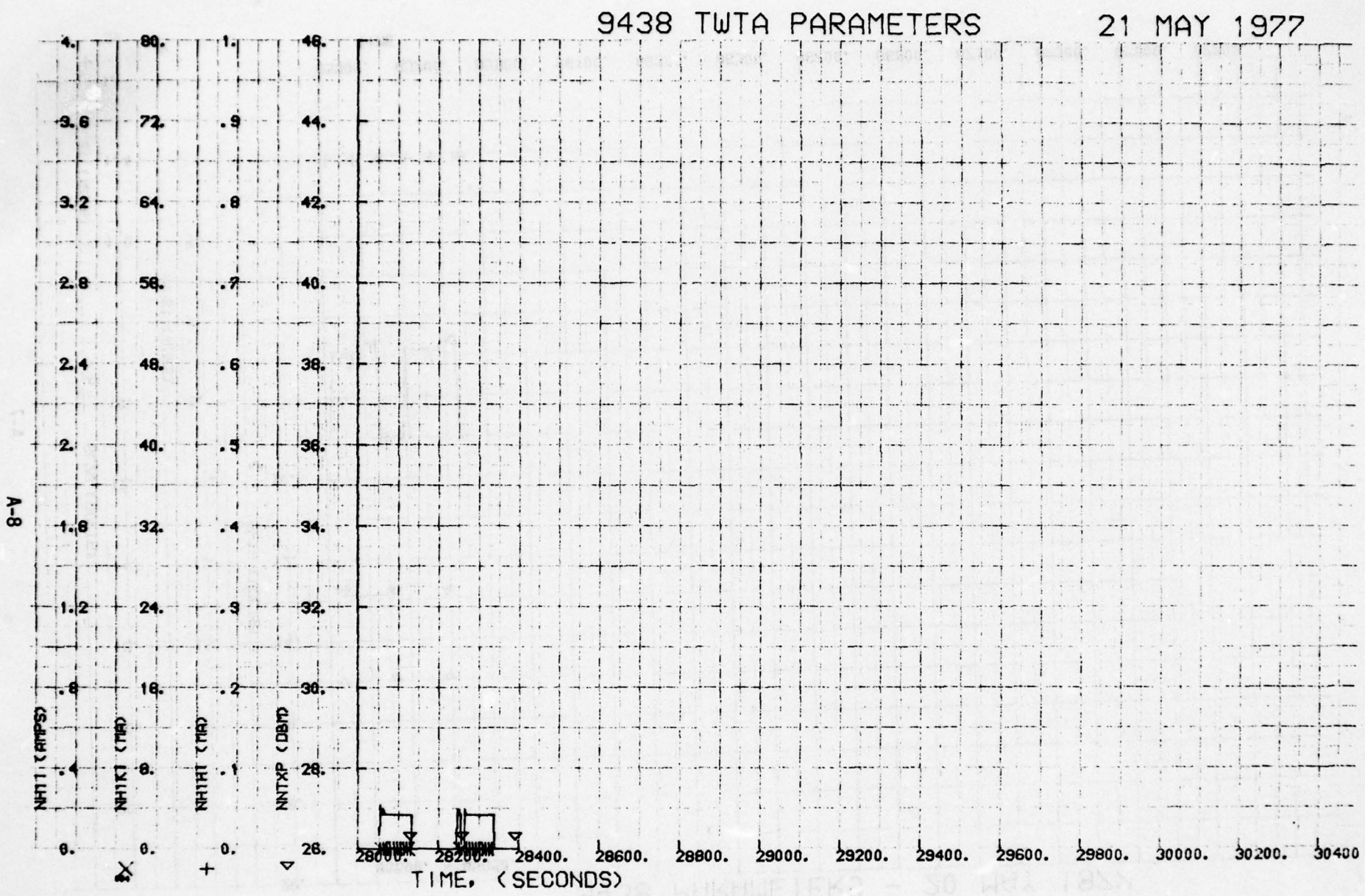
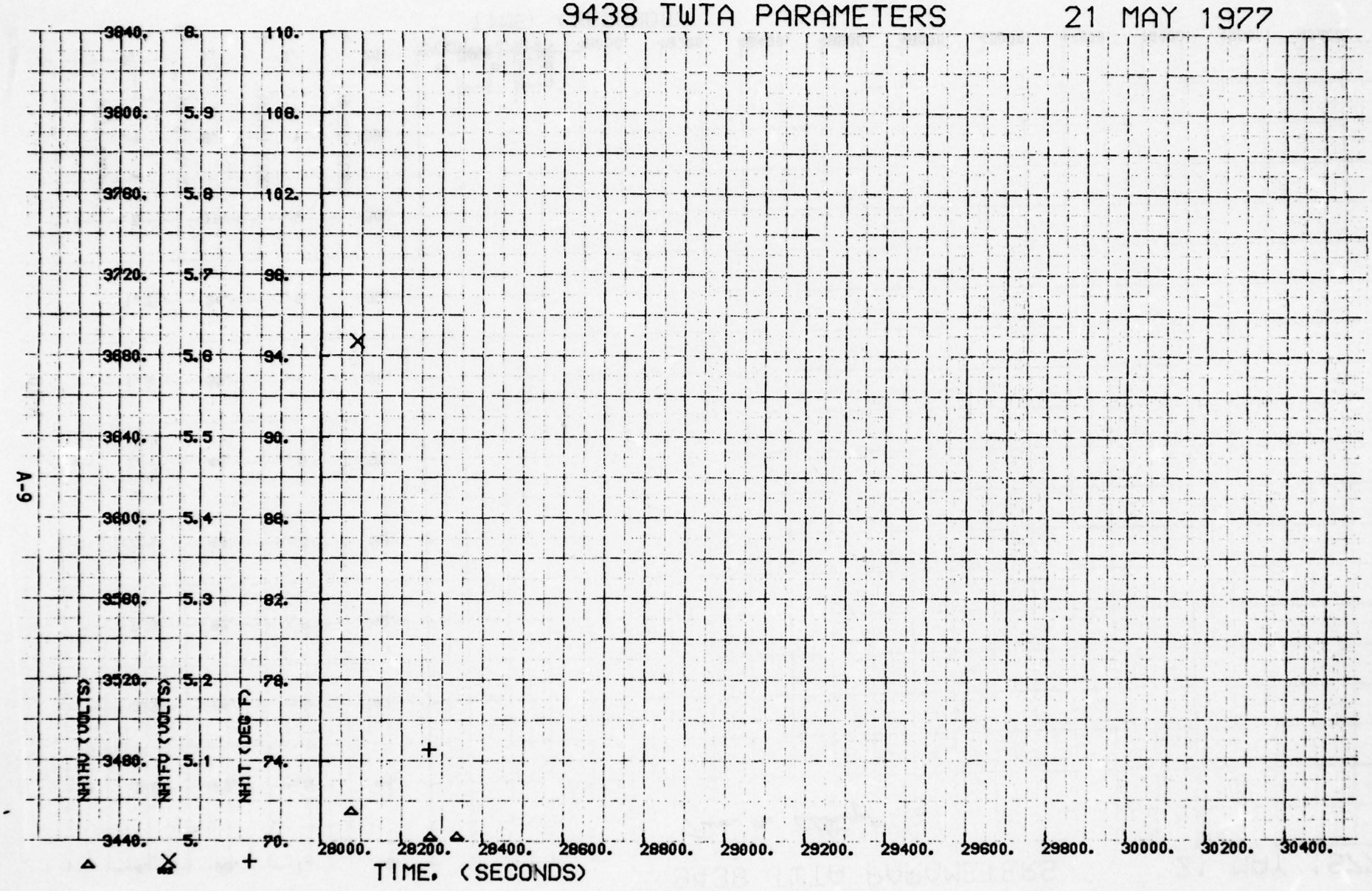

9438 TWTA PARAMETERS
21 MAY 1977
NHT1 (AMPS)
NH1K1 (MA)
NH1HT (MA)
NNTXP (DBM)
4. 3.6 3.2 2.8 2.4 2. 1.6 1.2 .8 .4 0.
80. 72. 64. 56. 48. 40. 32. 24. 16. 8. 0.
1. .9 .8 .7 .6 .5 .4 .3 .2 .1 0.
48. 44. 42. 40. 38. 36. 34. 32. 30. 28. 26.
28000. 28200. 28400. 28600. 28800. 29000. 29200. 29400. 29600. 29800. 30000. 30200. 30400
TIME, (SECONDS)


9438 TWTA PARAMETERS
21 MAY 1977
3840.
3800.
3760.
3720.
3680.
3640.
3600.
3560.
3520.
3480.
3440.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
NH1HV (VOLTS)
NH1FV (VOLTS)
NH1T (DEG F)
28000.
28200.
28400.
28600.
28800.
29000.
29200.
29400.
29600.
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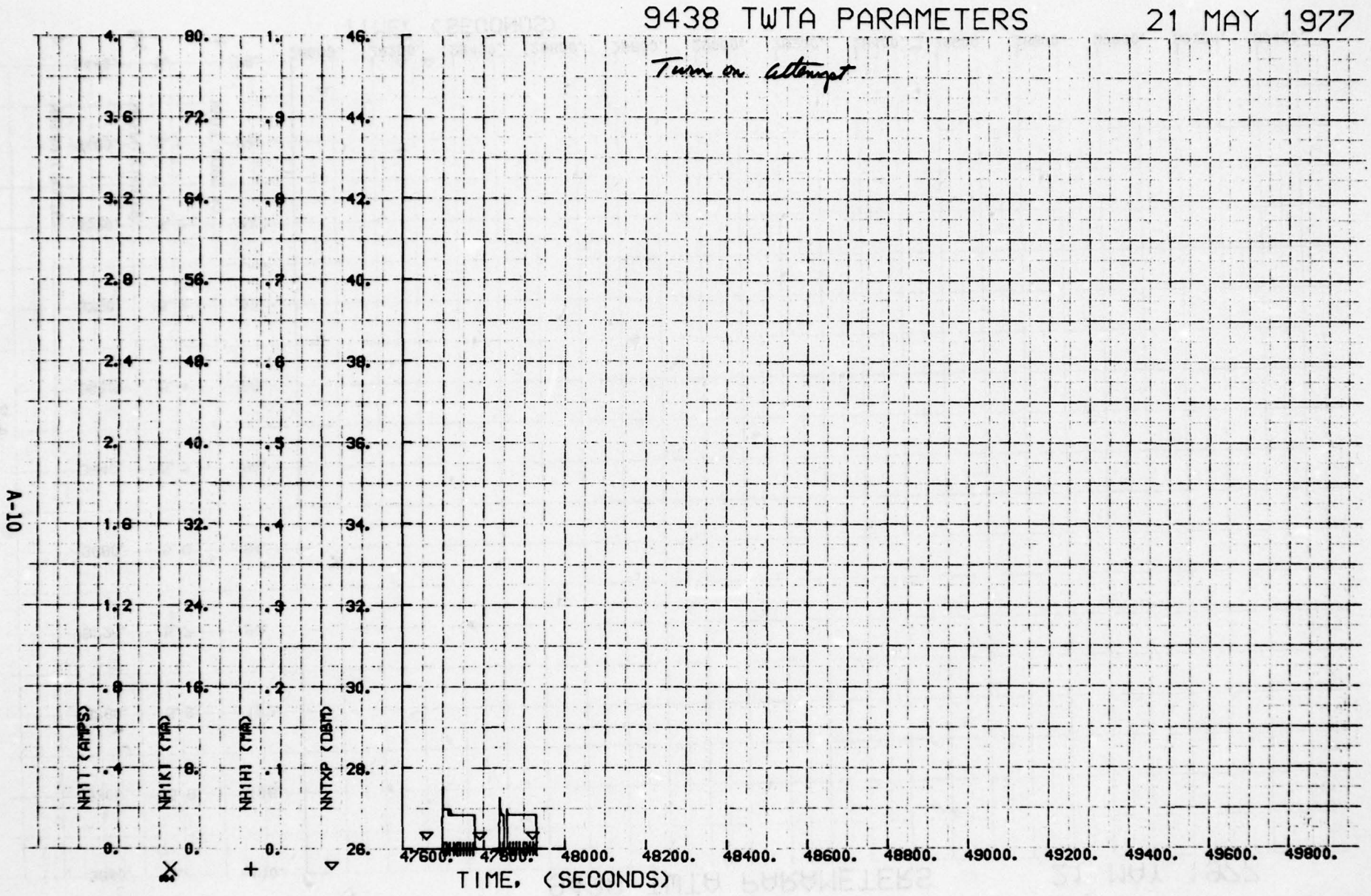
30400.
TIME, (SECONDS)


9438 TWTA PARAMETERS
21 MAY 1977
Turn on attempt
NH1T (AMPS)
NH1KT (MA)
NH1HI (MA)
NNTXP (DBM)
TIME, (SECONDS)
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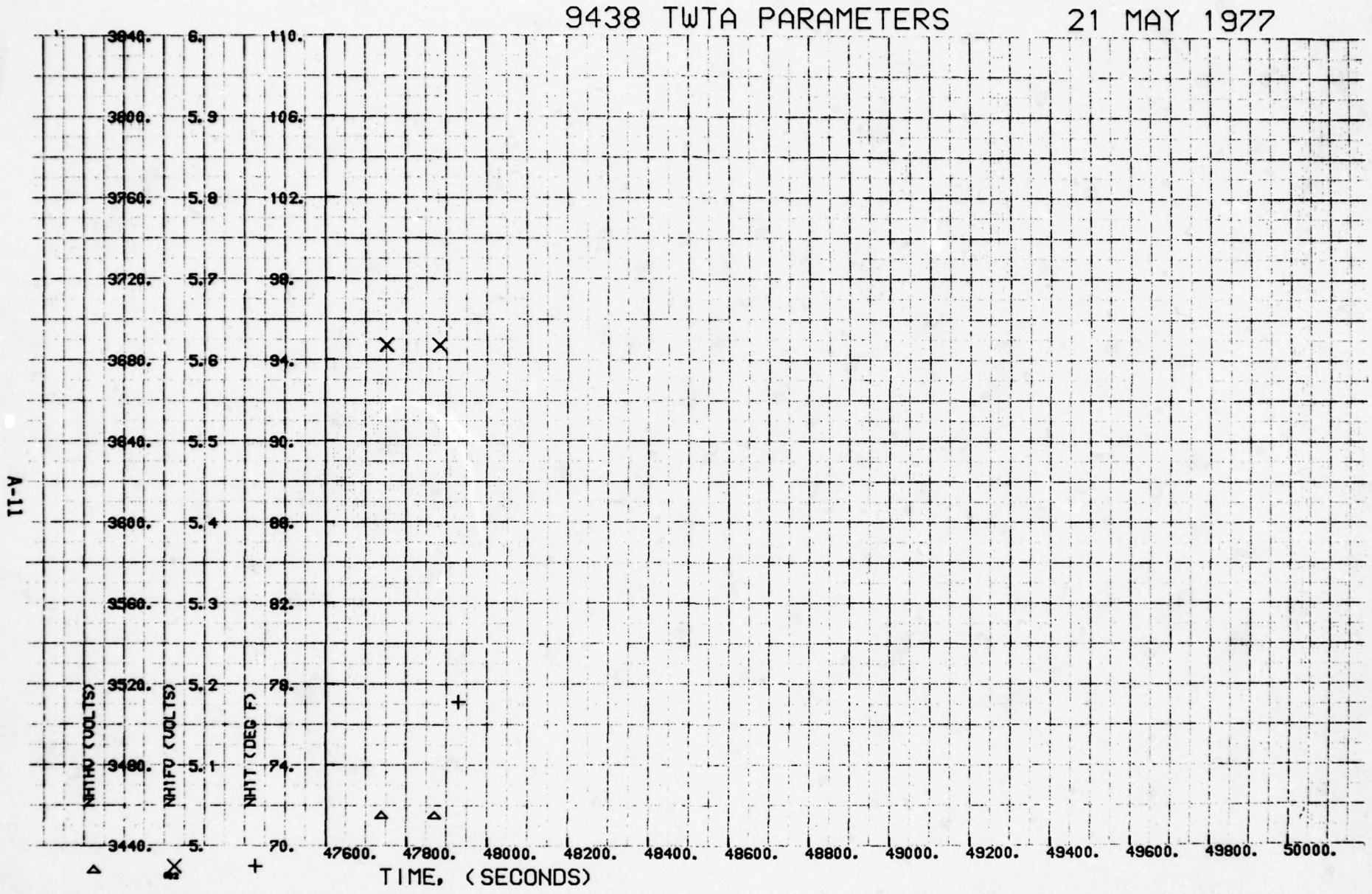
48000.
48200.
48400.
48600.
48800.
49000.
49200.
49400.
49600.
49800.


9438 TWTA PARAMETERS
21 MAY 1977
NHTHV (VOLTS)
NHIFV (VOLTS)
NHTT (DEG F)
3640.
3600.
3560.
3520.
3480.
3440.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
47600.
47800.
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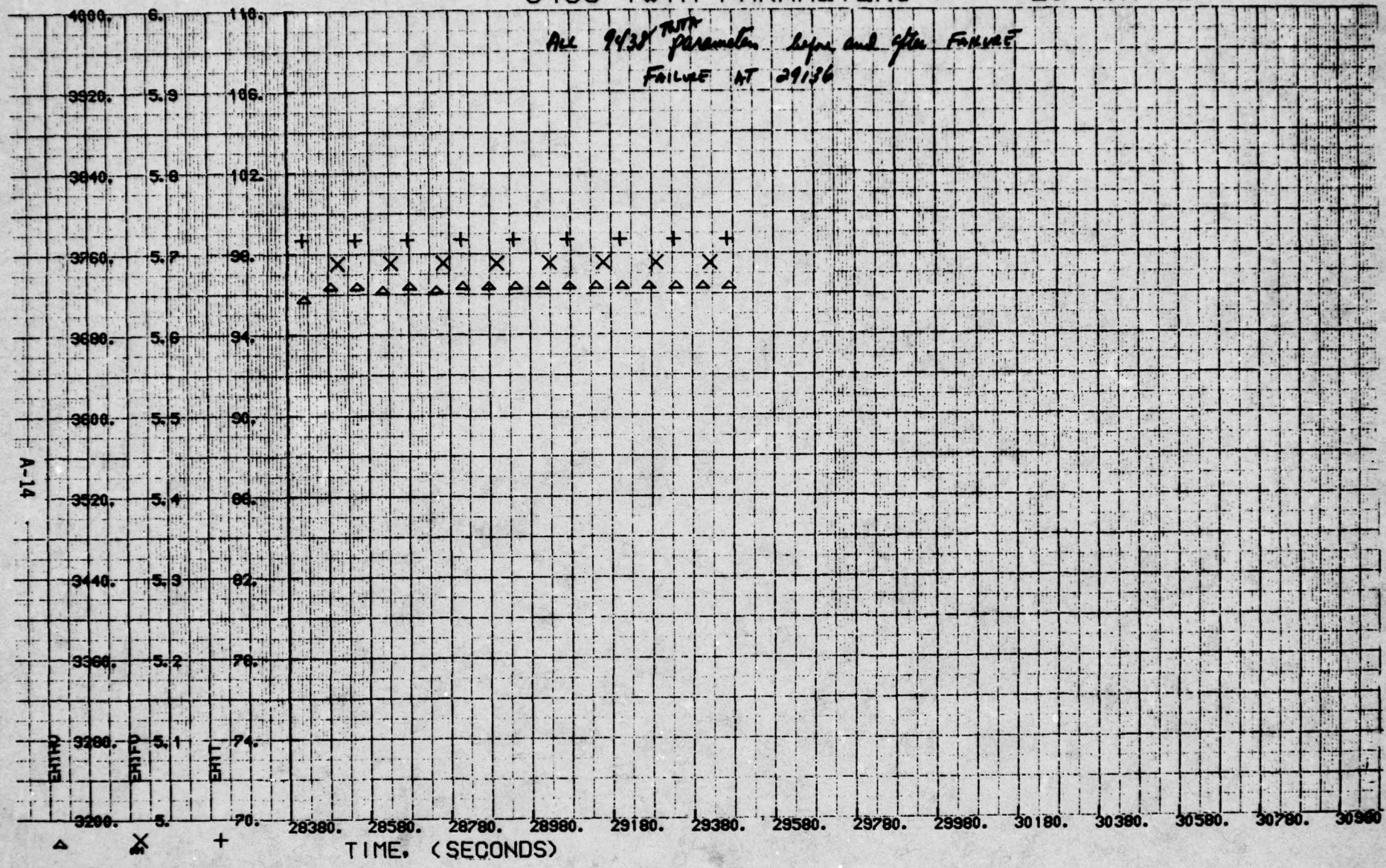
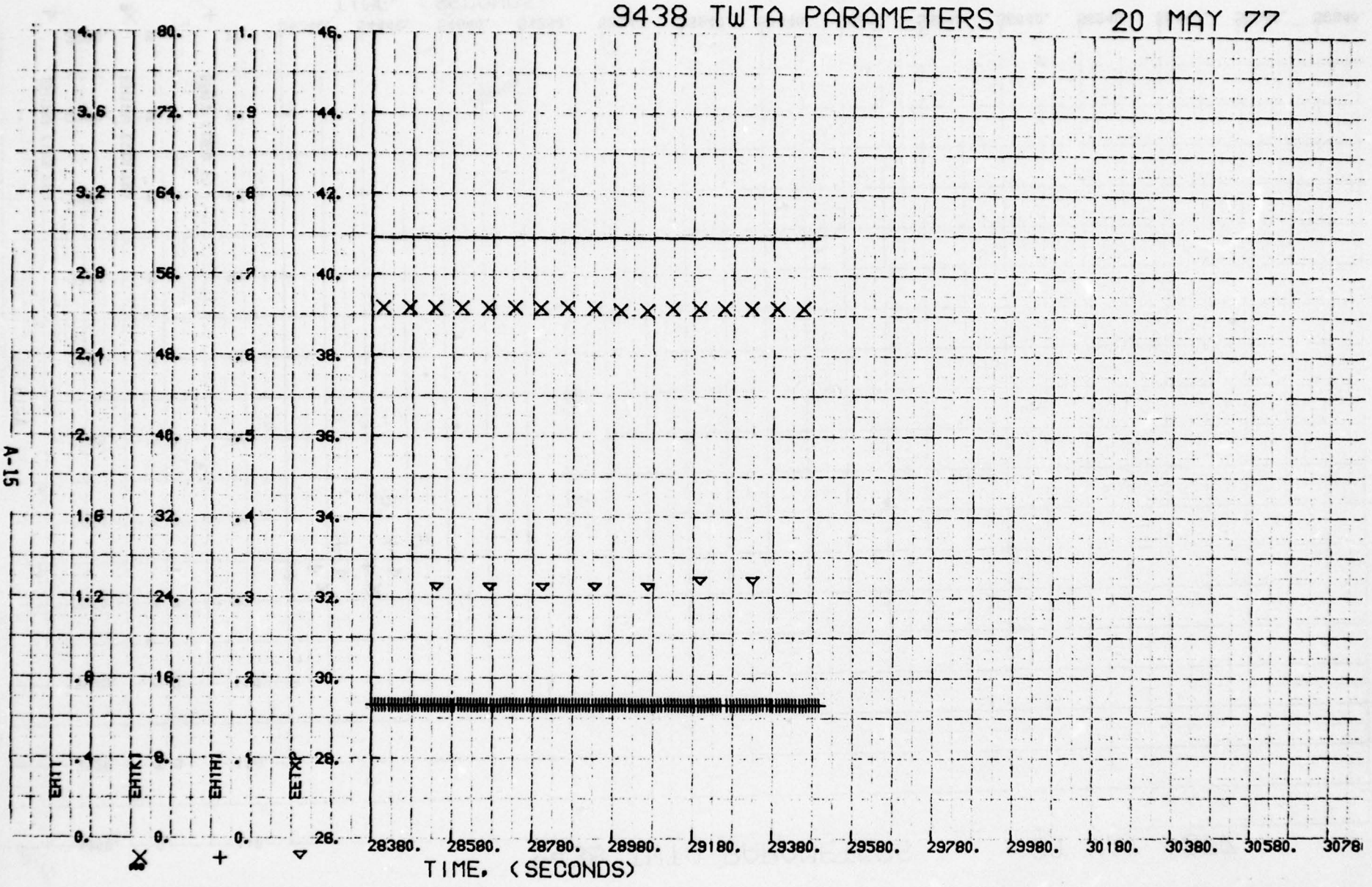
48200.
48400.
48600.
48800.
49000.
49200.
49400.
49600.
49800.
50000.
TIME, (SECONDS)

APPENDIX A-2

F8 ECHLTWTA TELEMETRY PARAMETERS AT FAILURE OF NCHLTWTA-1 AND DURING SUBSEQUENT NCHLTWTA-1 ATTEMPTED RESTARTS

9438 TWTA PARAMETERS 20 MAY 77




9438 TWTA PARAMETERS
20 MAY 77
EHTI
EHTKI
EHTAI
EETXP
4.
3.6
3.2
2.8
2.4
2.
1.6
1.2
.8
.4
0.
80.
72.
64.
56.
48.
40.
32.
24.
16.
8.
0.
1.
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.
46.
44.
42.
40.
38.
36.
34.
32.
30.
28.
28380.
28580.
28780.
28980.
29180.
29380.
29580.
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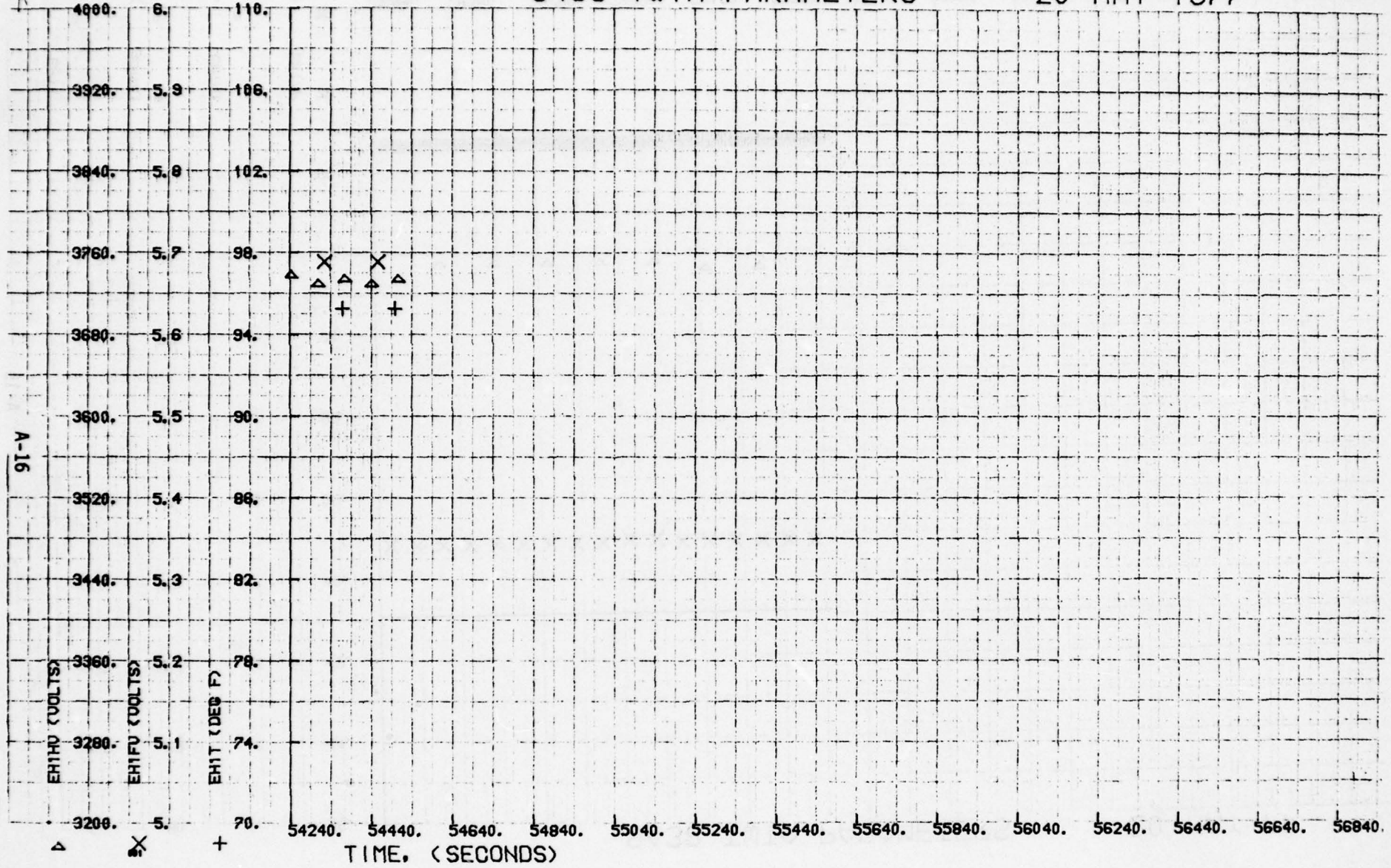
30580.
TIME, (SECONDS)

A-13

9438 TWTA PARAMETERS 20 MAY 1977



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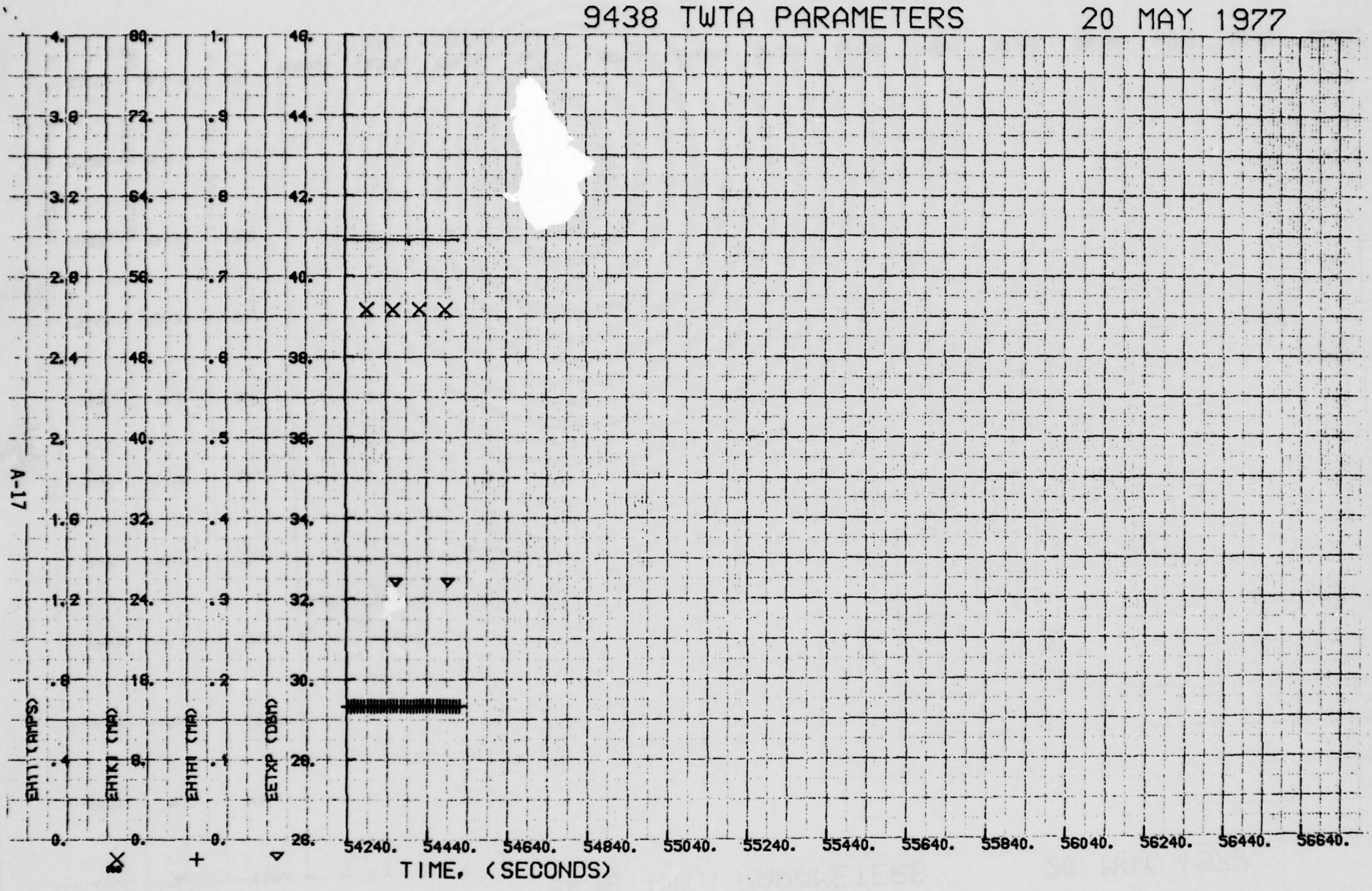
9438 TWTA PARAMETERS
20 MAY 1977
EH11 (AMPS)
EH1K1 (MA)
EH1H1 (MA)
EETXP (DBM)
TIME, (SECONDS)
54240.
54440.
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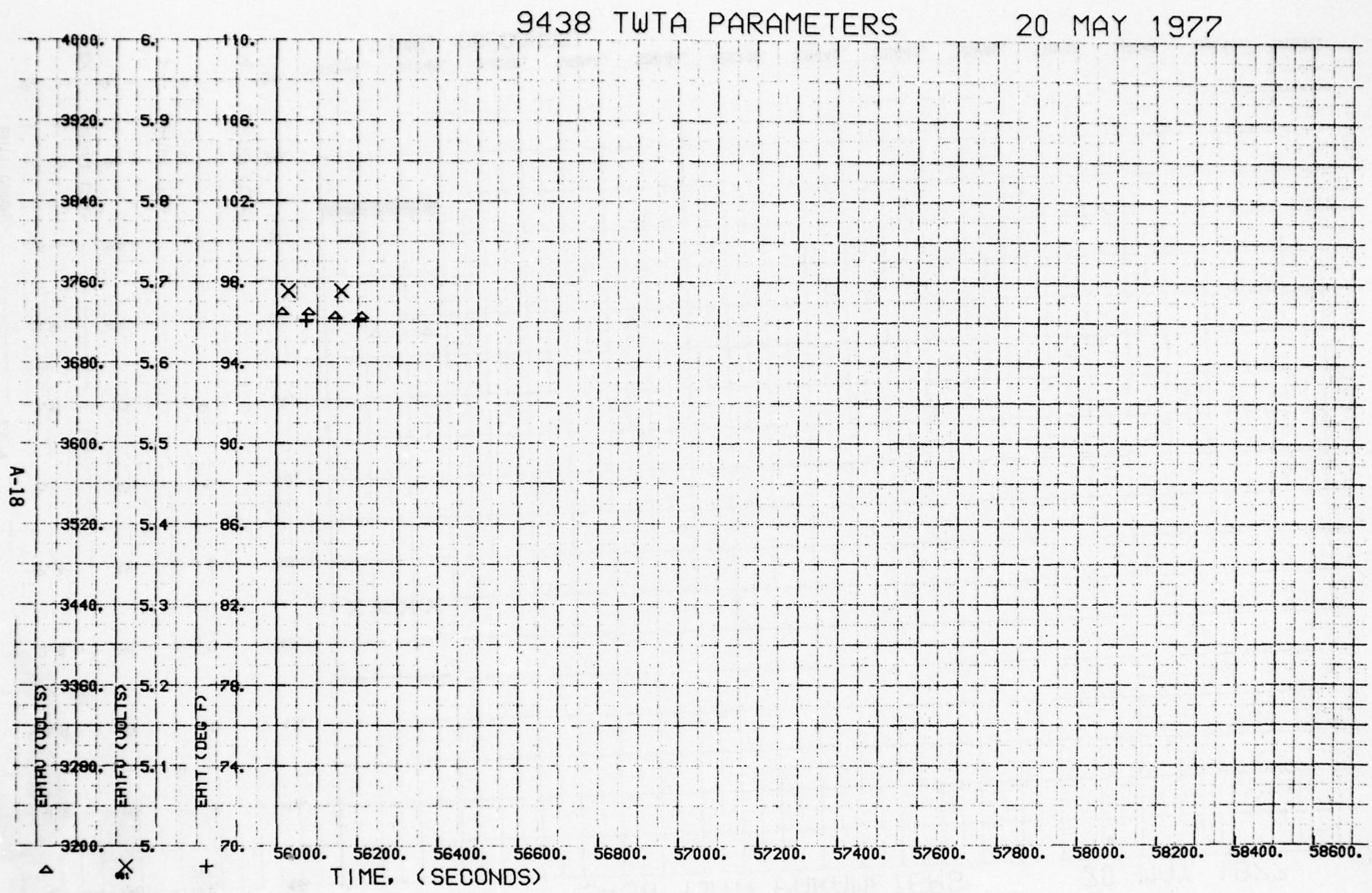
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20 MAY 1977
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3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
EMIAV (VOLTS)
EMIFV (VOLTS)
EMIT (DEG F)
56000.
56200.
56400.
56600.
56800.
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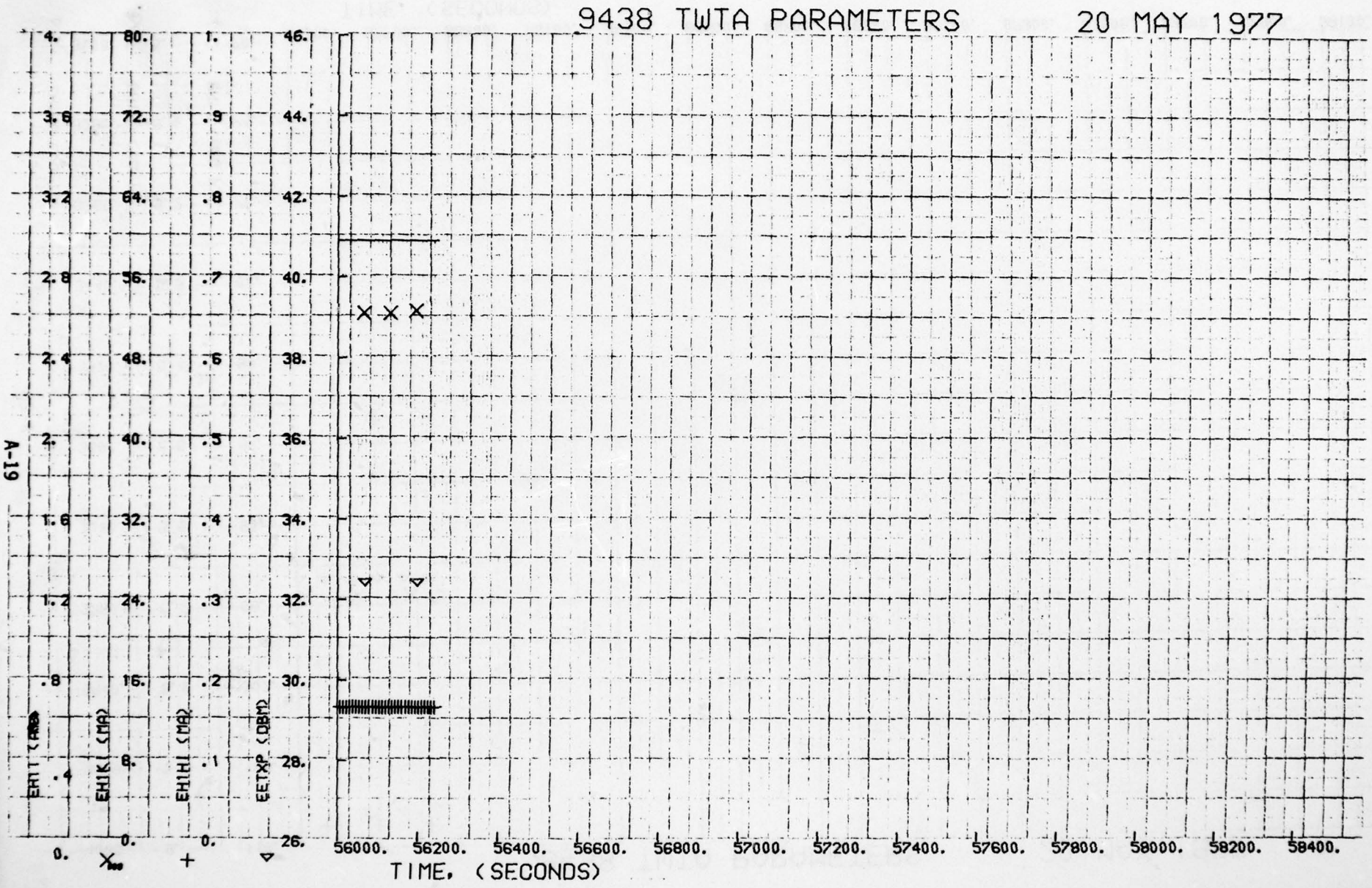
58600.
TIME, (SECONDS)


9438 TWTA PARAMETERS
20 MAY 1977
EHTT (KV)
EH1K (MA)
EH1HI (MA)
EETXP (DBM)
TIME, (SECONDS)
56000.
56200.
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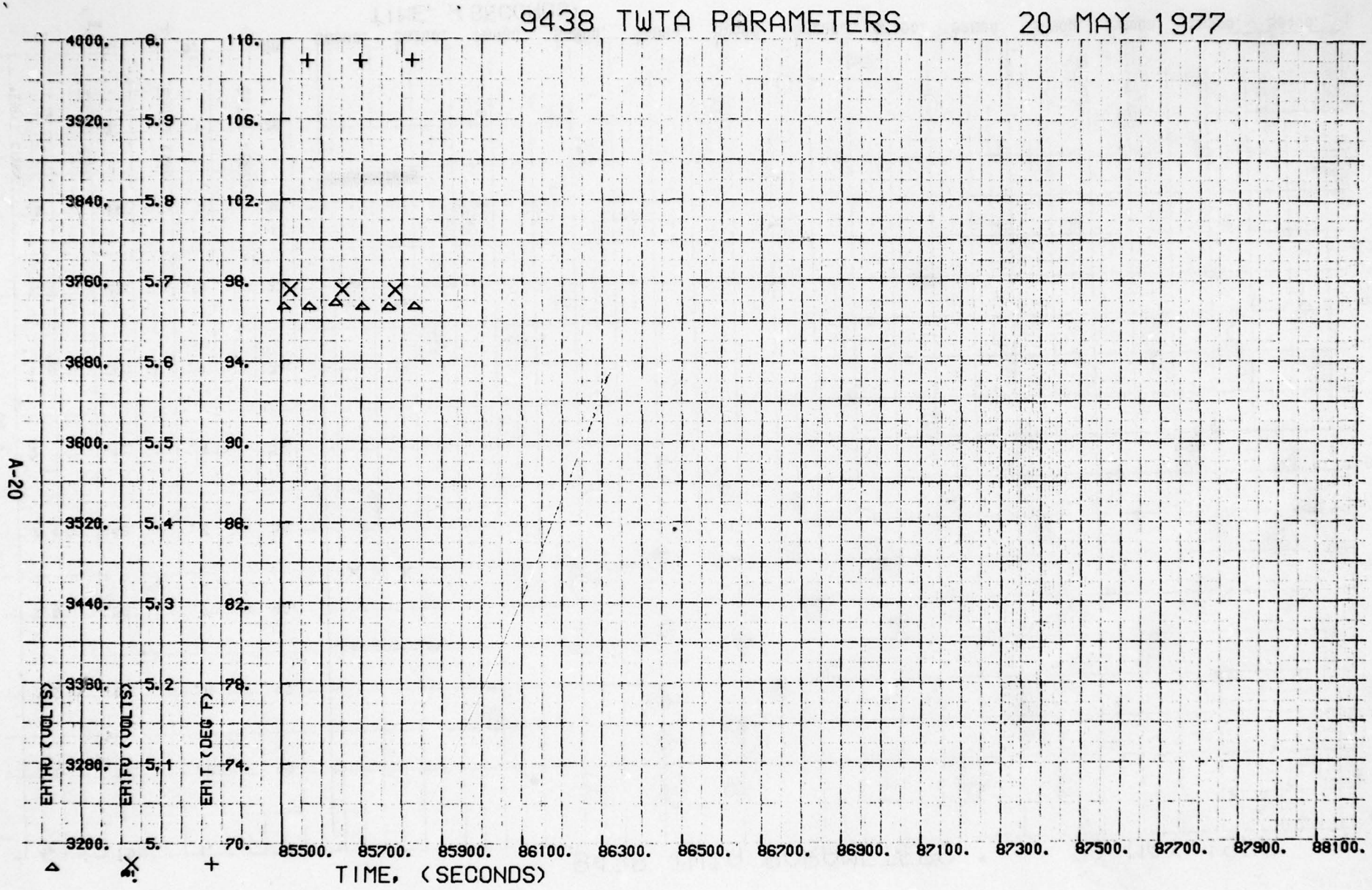
9438 TWTA PARAMETERS
20 MAY 1977
EHTHV (VOLTS)
EHIFV (VOLTS)
EHIT (DEG F)
4000.
3920.
3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
85500.
85700.
85900.
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86300.
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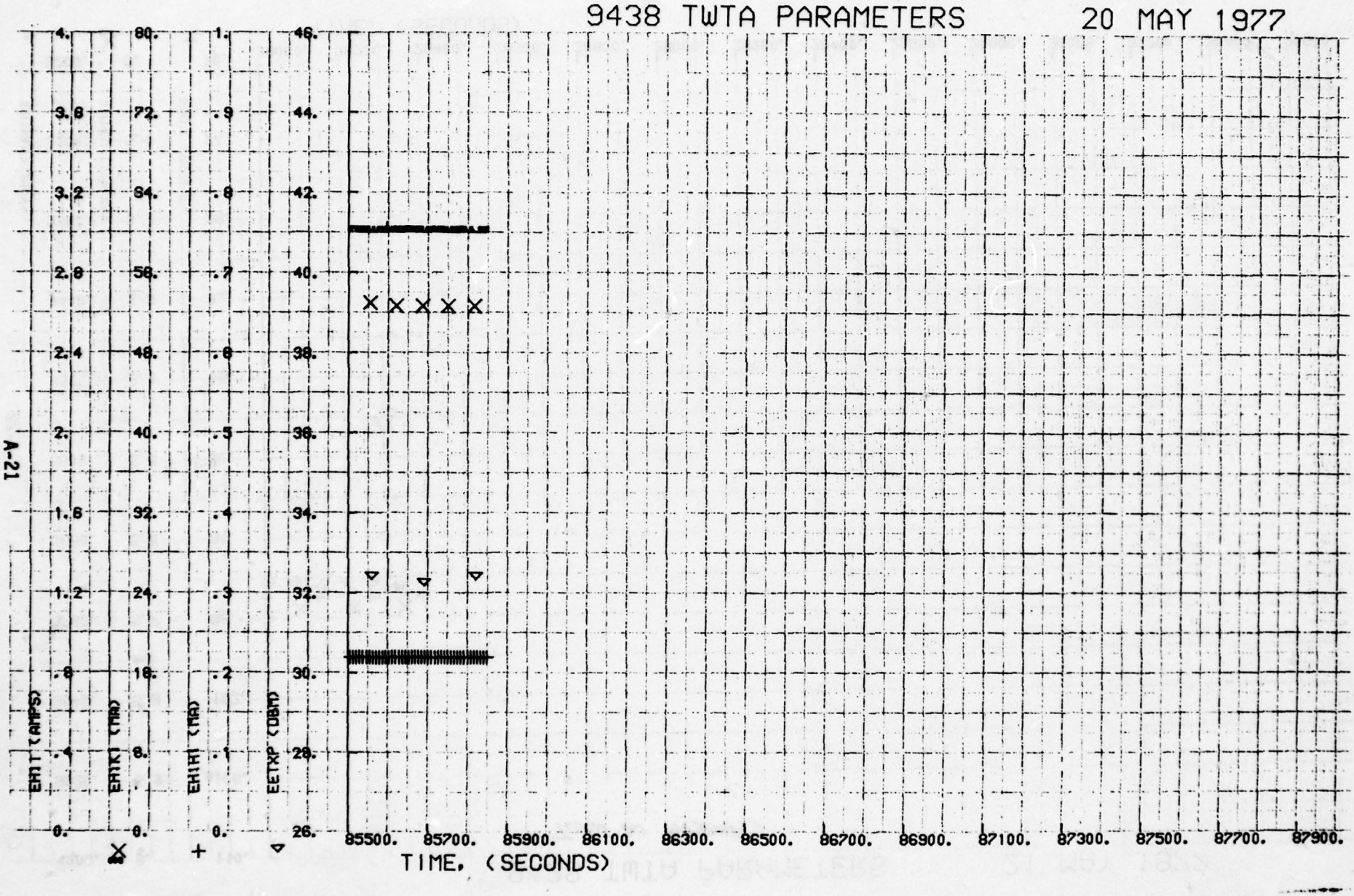
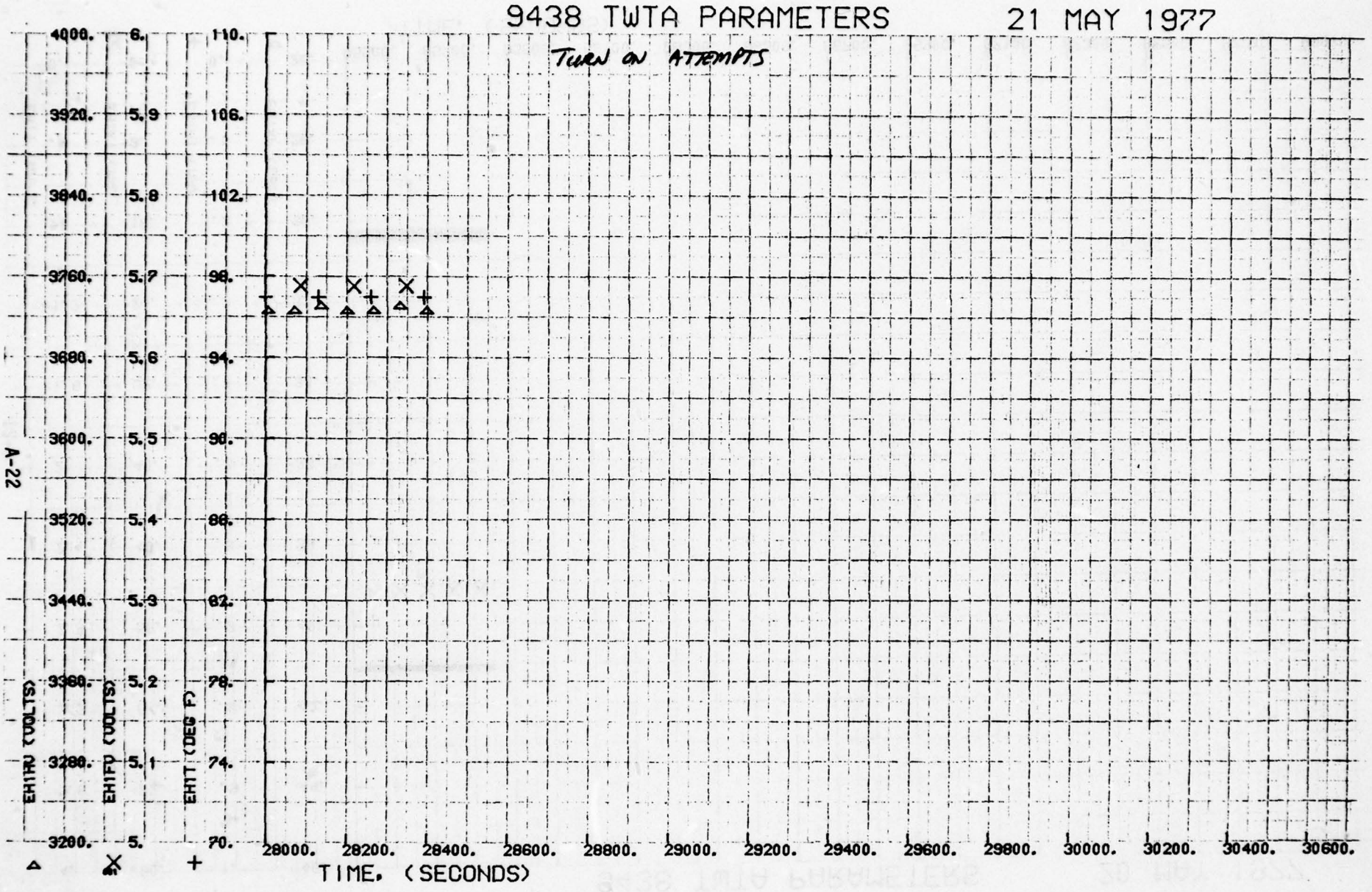
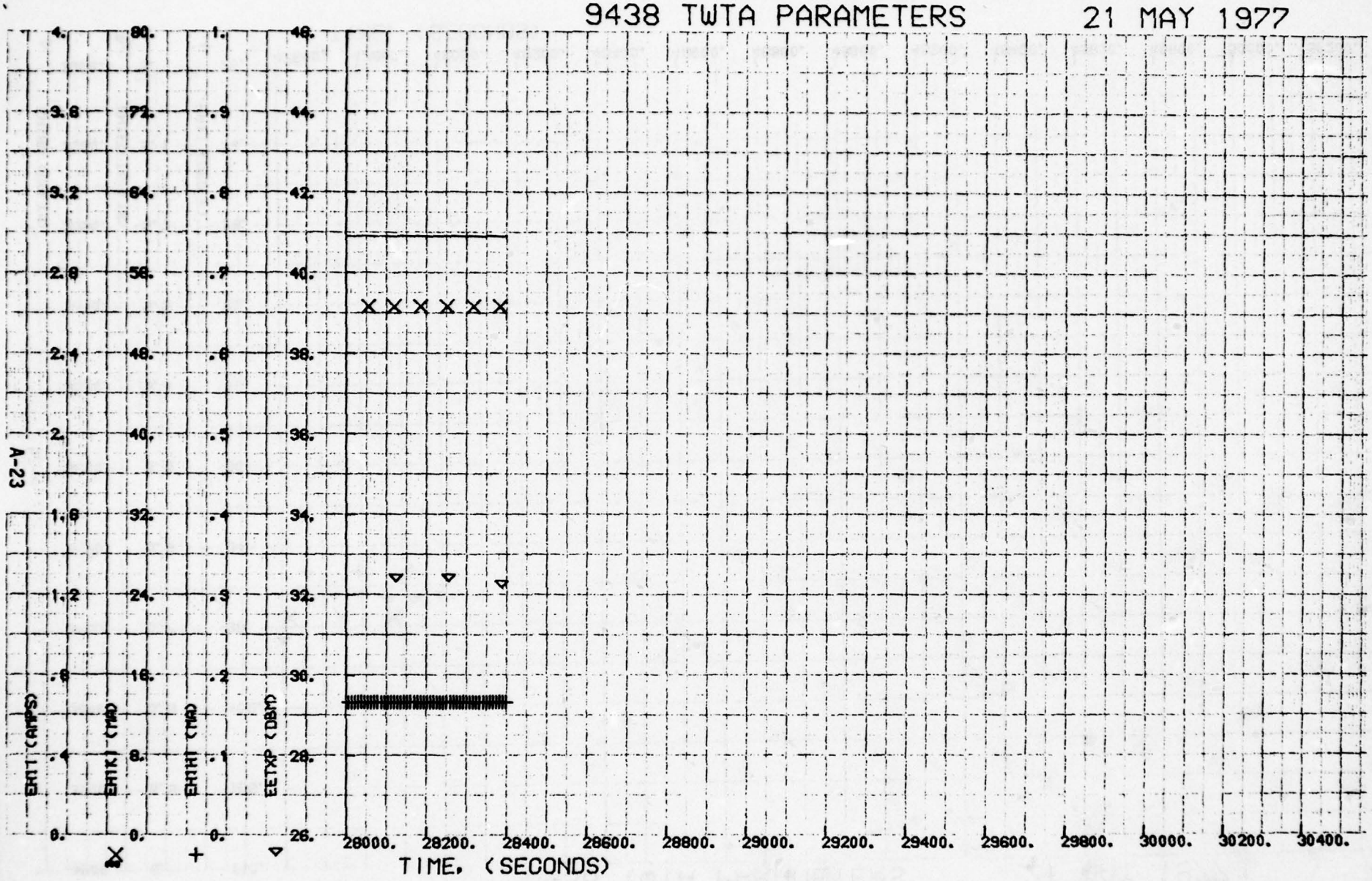
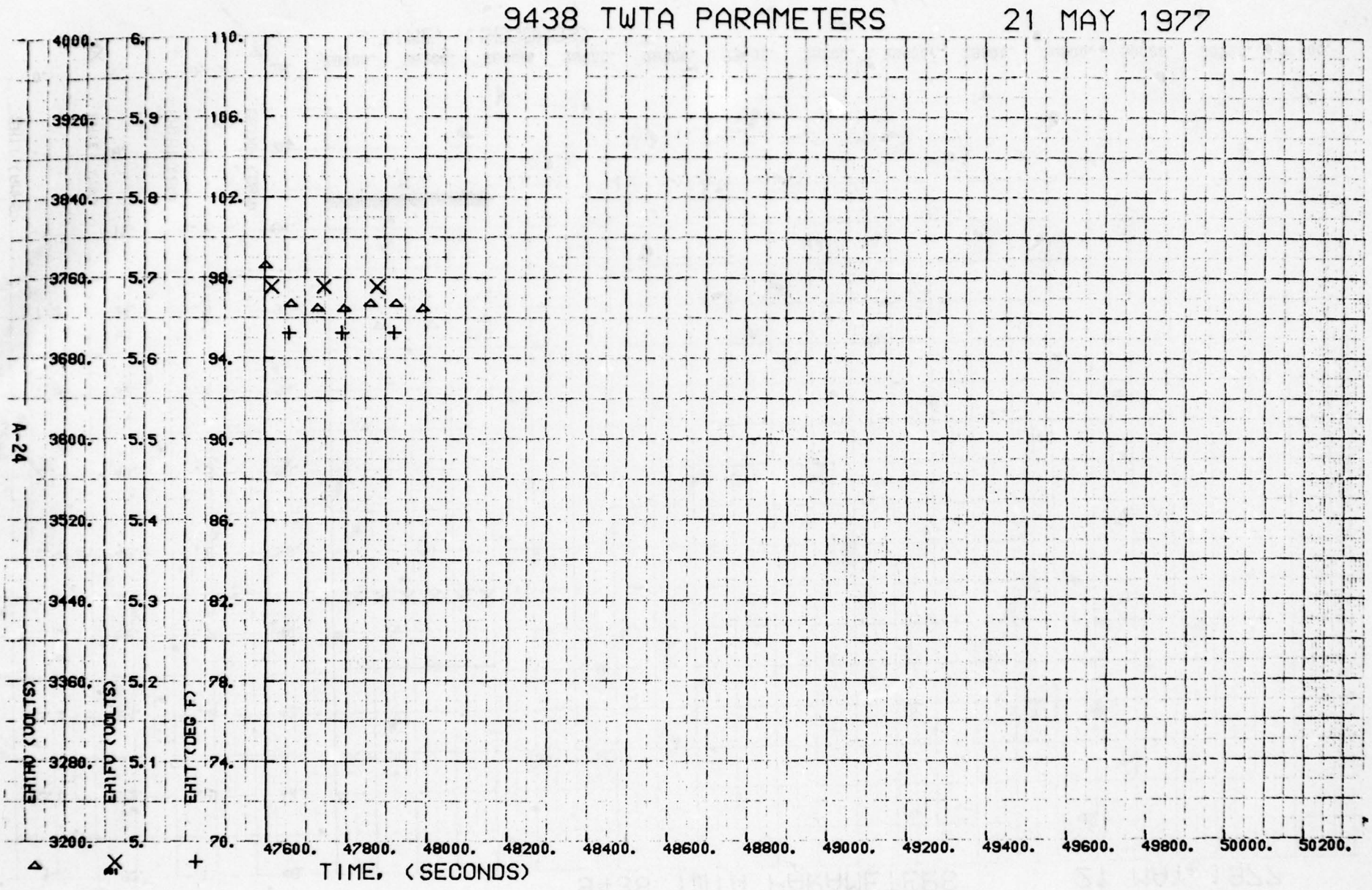
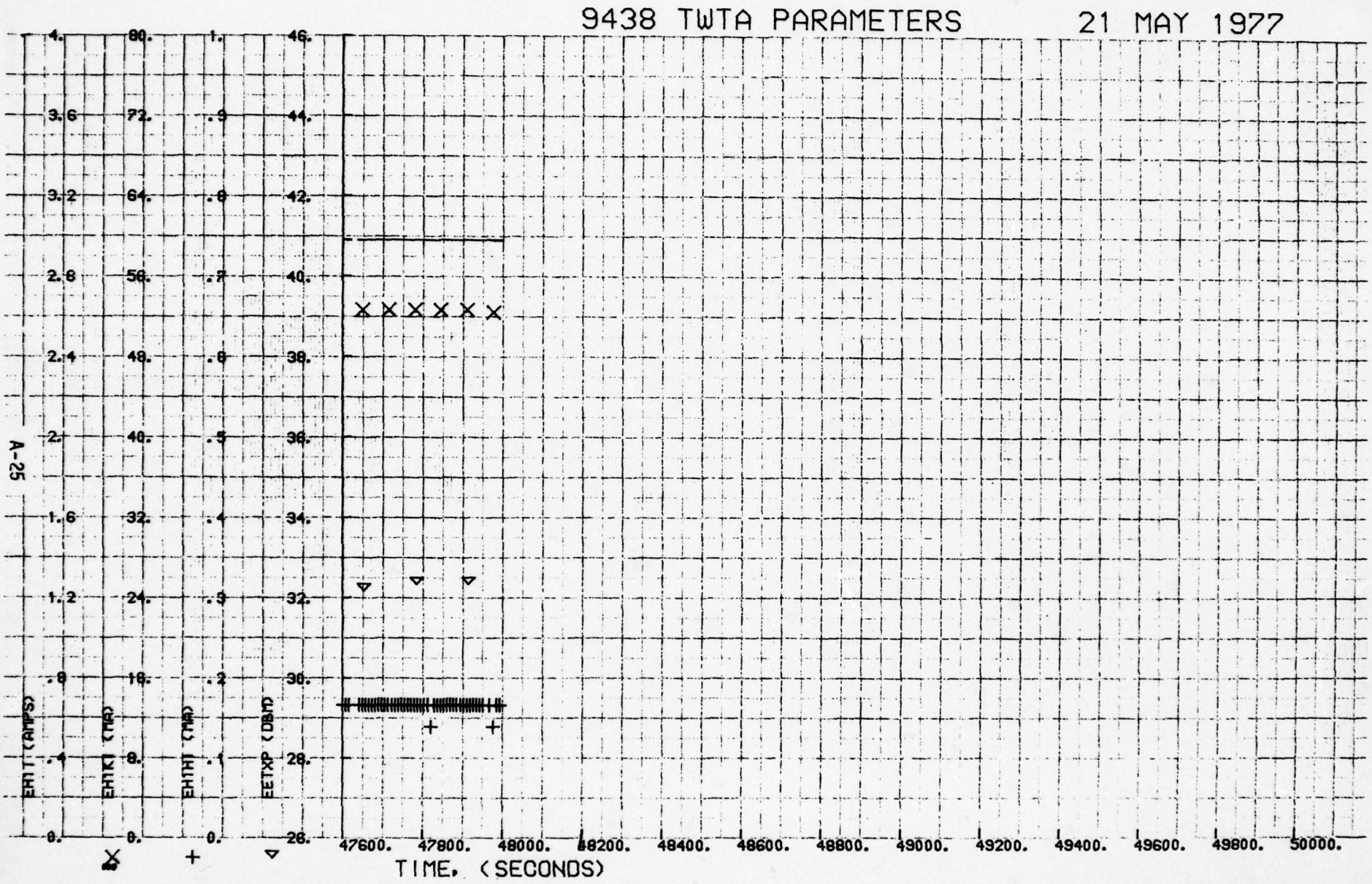
86700.
86900.
87100.
87300.
87500.
87700.
87900.
88100.
TIME, (SECONDS)


9438 TWTA PARAMETERS
20 MAY 1977
EMIT (AMPS)
EMIK (MA)
EMIH (MA)
EETXP (DBM)
TIME, (SECONDS)
85500.
85700.
85900.
86100.
86300.
86500.
86700.
86900.
87100.
87300.
87500.
87700.
87900.


9438 TWTA PARAMETERS 21 MAY 1977
TURN ON ATTEMPTS
4000.
3920.
3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
EHINU (VOLTS)
EHIFU (VOLTS)
EHIT (DEG F)
28000.
28200.
28400.
28600.
28800.
29000.
29200.
29400.
29600.
29800.
30000.
30200.
30400.
30600.
TIME. (SECONDS)

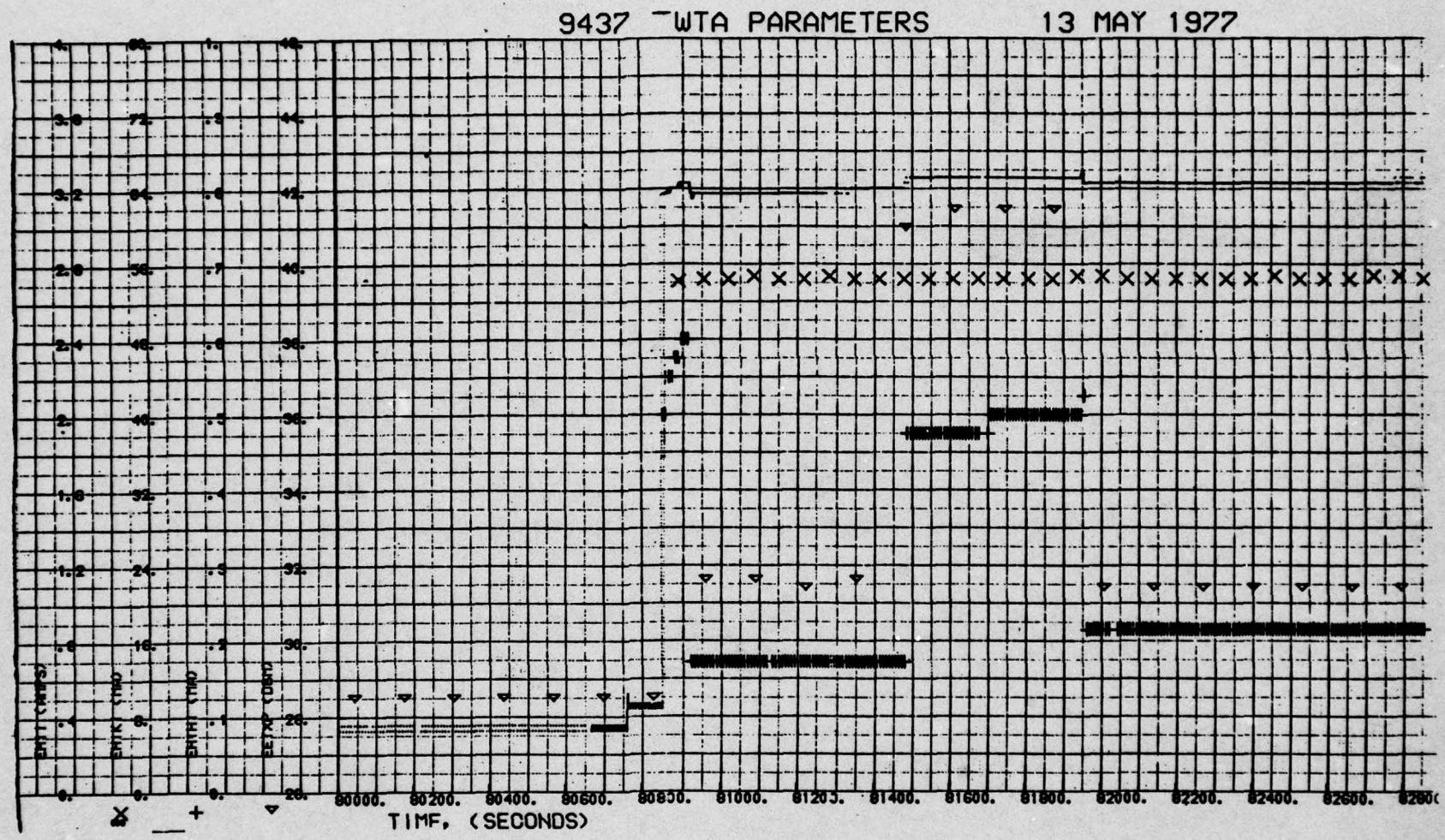

9438 TWTA PARAMETERS
21 MAY 1977
EHT (AMPS)
EHK (MA)
EHHI (MA)
EETXP (DBM)
TIME, (SECONDS)
28000.
28200.
28400.
28600.
28800.
29000.
29200.
29400.
29600.
29800.
30000.
30200.
30400.

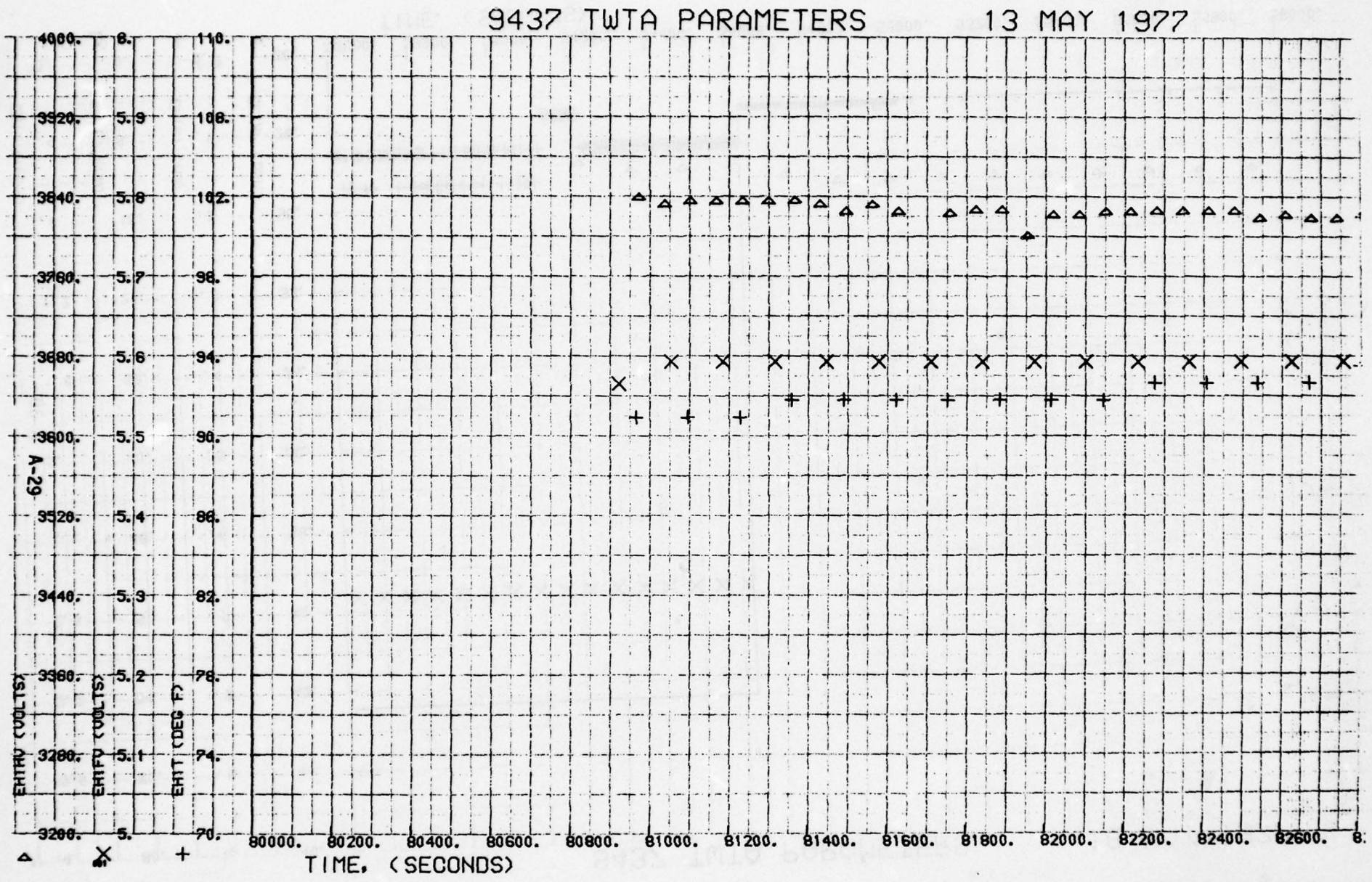

9438 TWTA PARAMETERS
21 MAY 1977
EHTHD (VOLTS)
EHTFD (VOLTS)
EHTT (DEG F)
TIME, (SECONDS)
4000.
3920.
3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
47600.
47800.
48000.
48200.
48400.
48600.
48800.
49000.
49200.
49400.
49600.
49800.
50000.
50200.

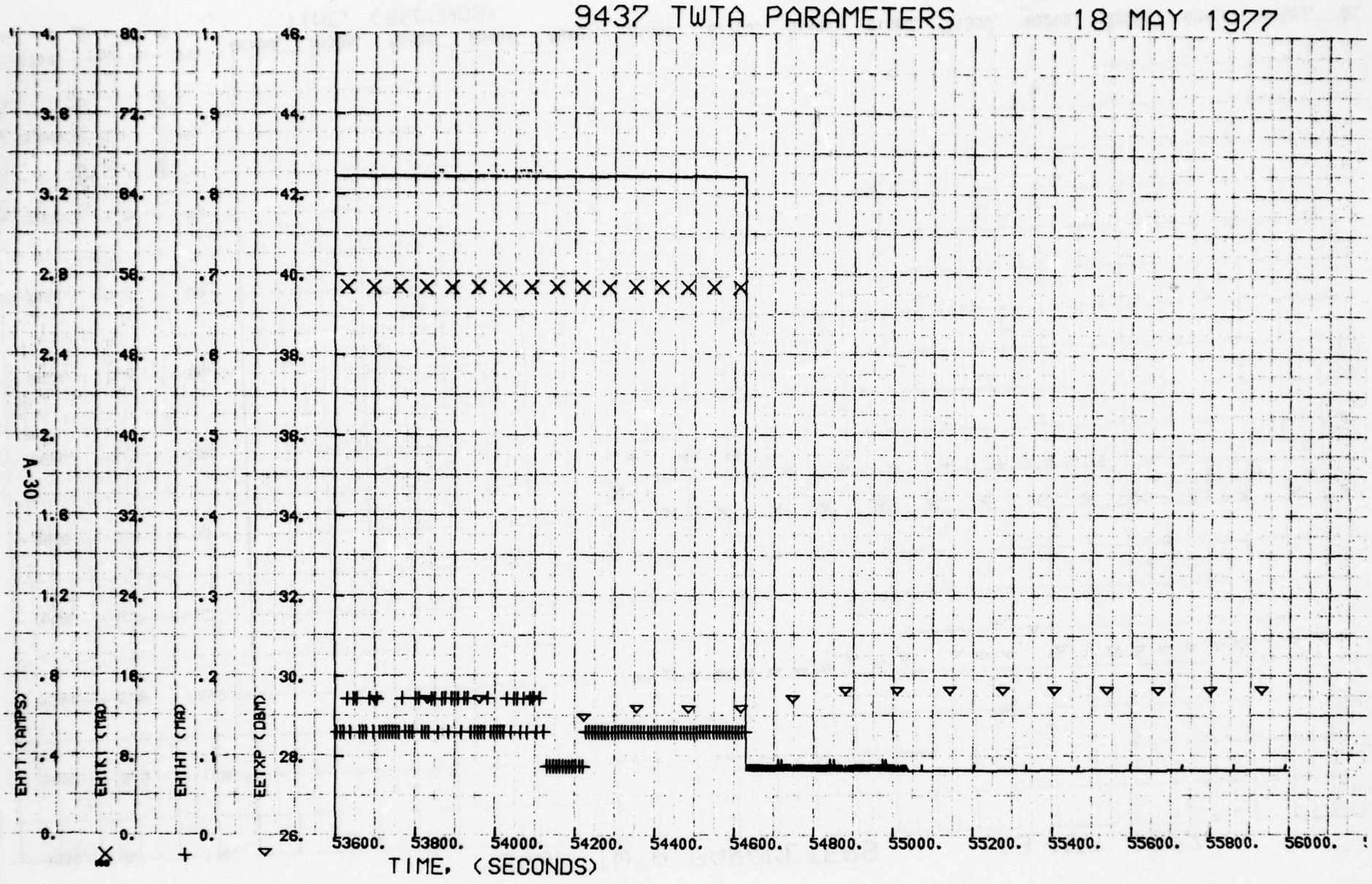

9438 TWTA PARAMETERS
21 MAY 1977
EHT (AMPS)
EHTK (MA)
EHTH (MA)
EETXP (DBM)
TIME, (SECONDS)
47600.
47800.
48000.
48200.
48400.
48600.
48800.
49000.
49200.
49400.
49600.
49800.
50000.

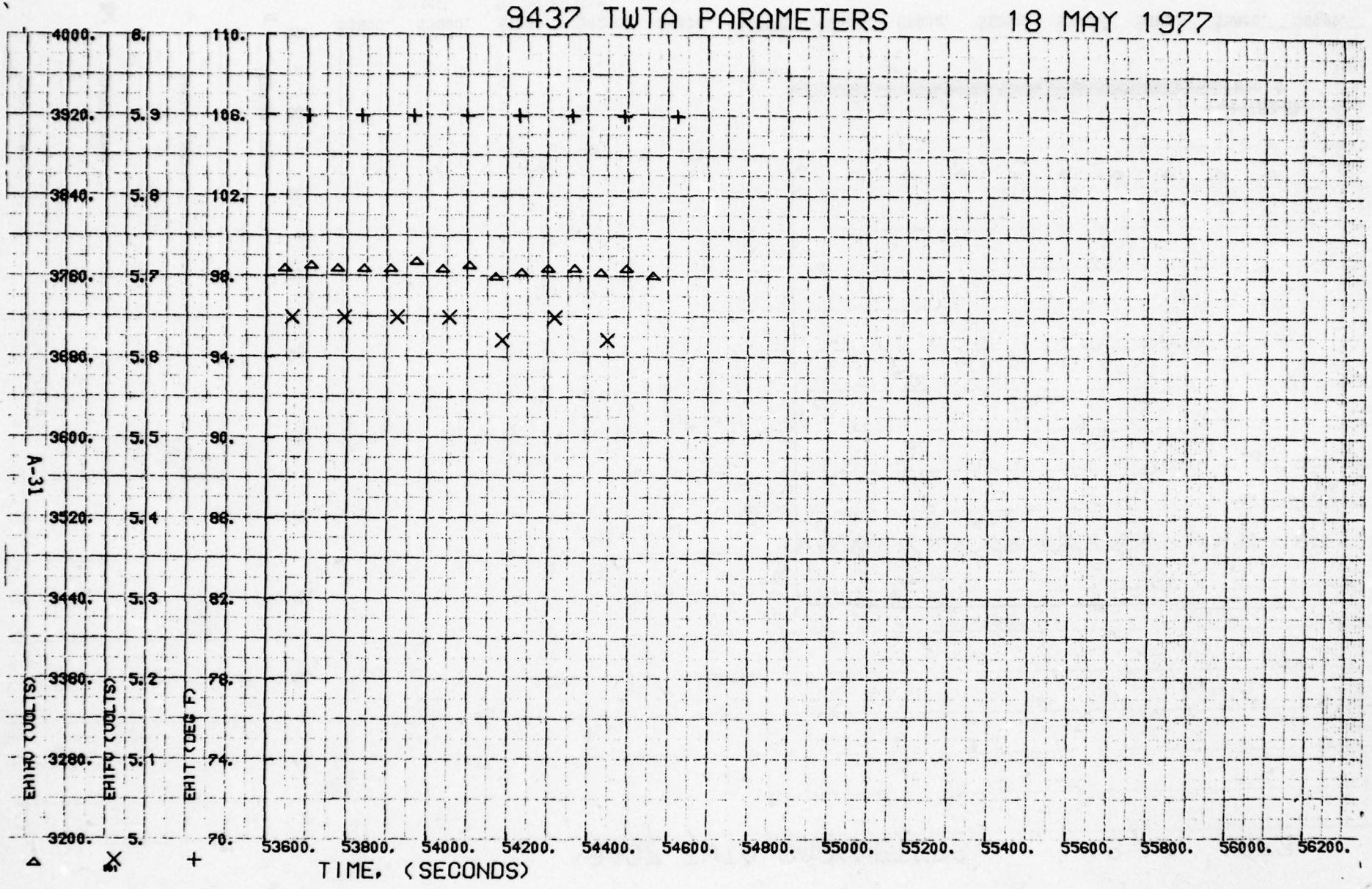
APPENDIX A-3

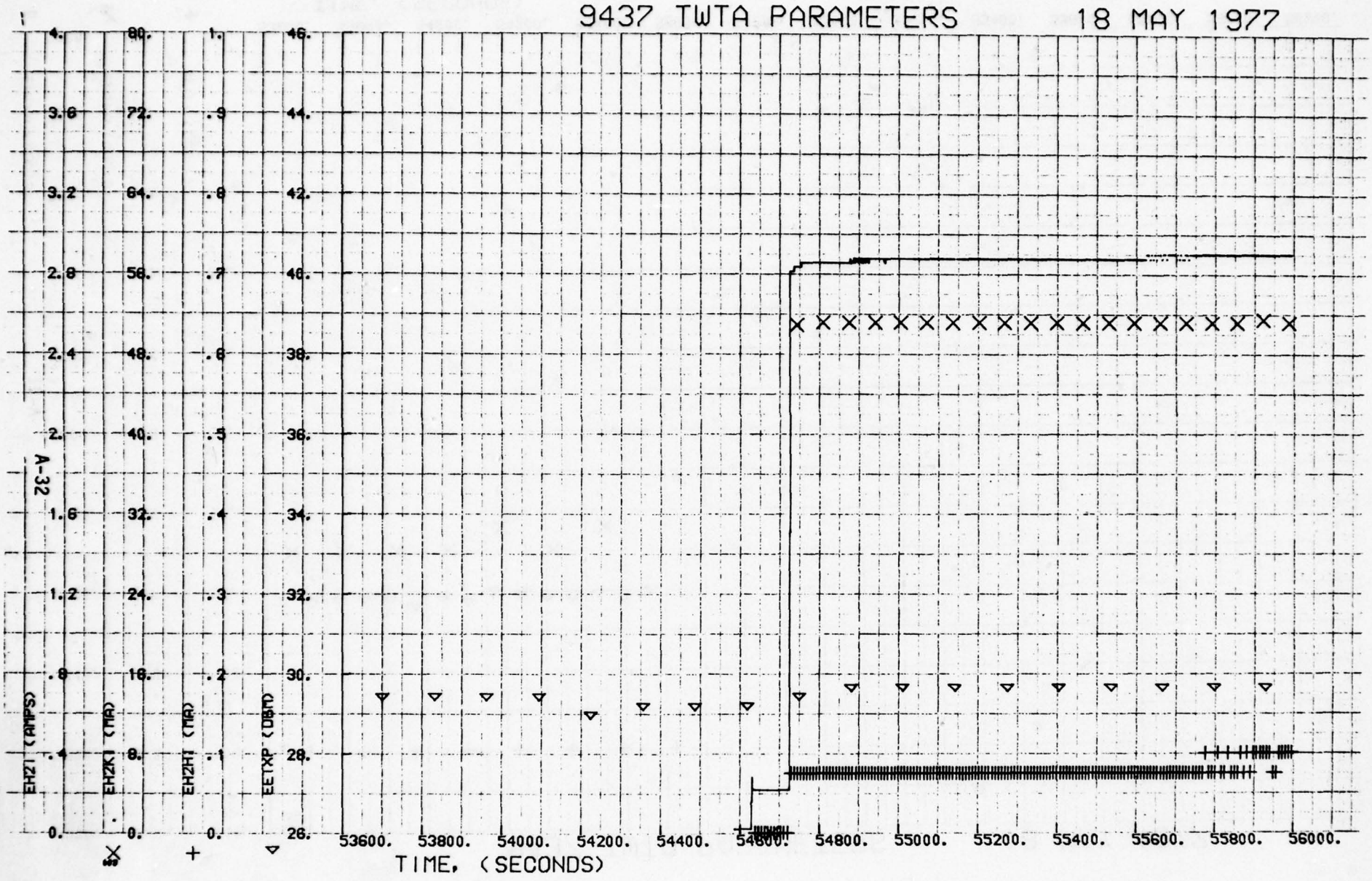
F7 AND F8 HLTWTA TELEMETRY PARAMETERS AT INITIAL TURN ON AND WHILE OPERATING

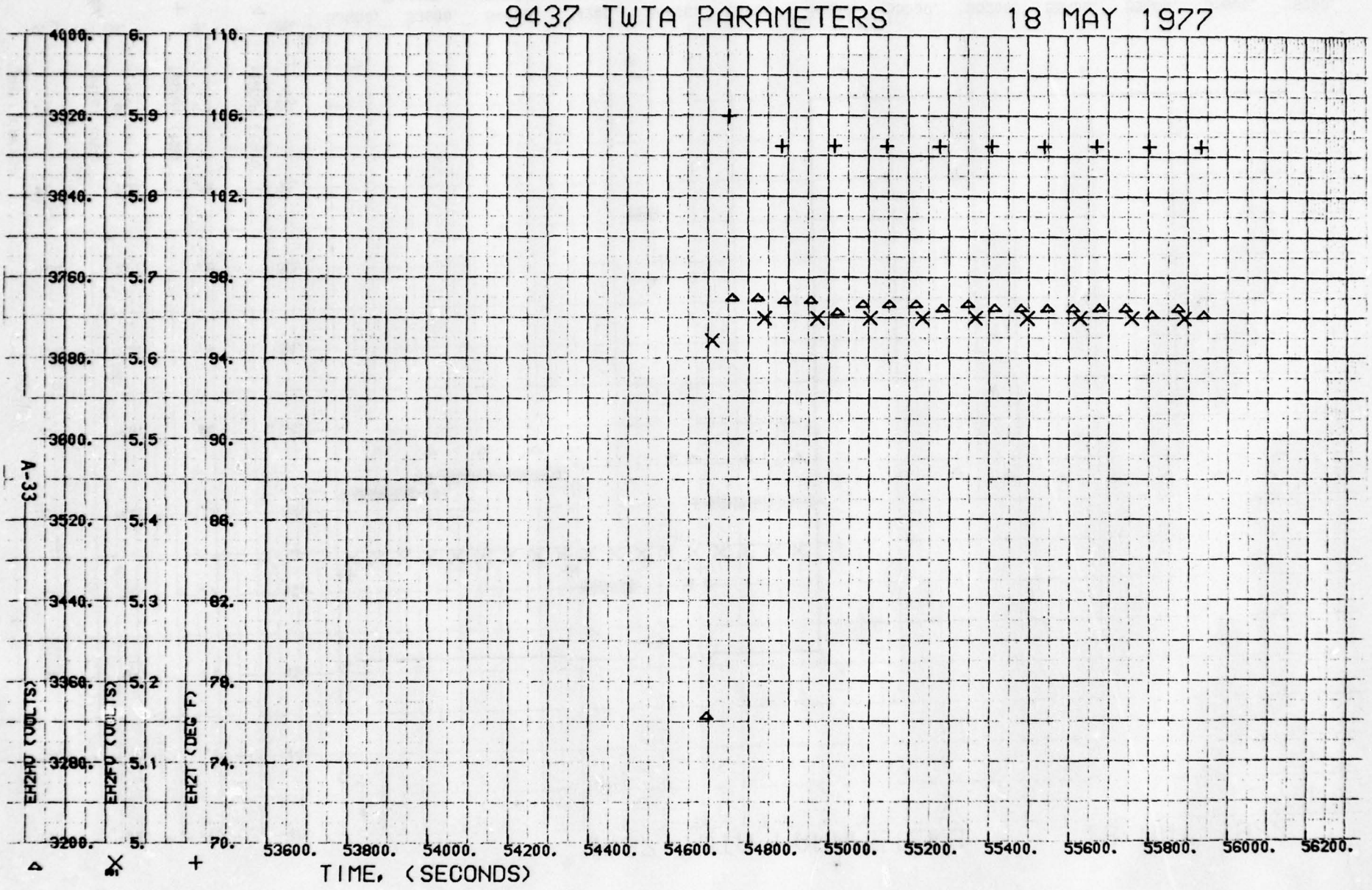

9437 TWTA PARAMETERS 13 MAY 1977
TIME (SECONDS)
80000.
80200.
80400.
80600.
80800.
81000.
81200.
81400.
81600.
81800.
82000.
82200.
82400.
82600.

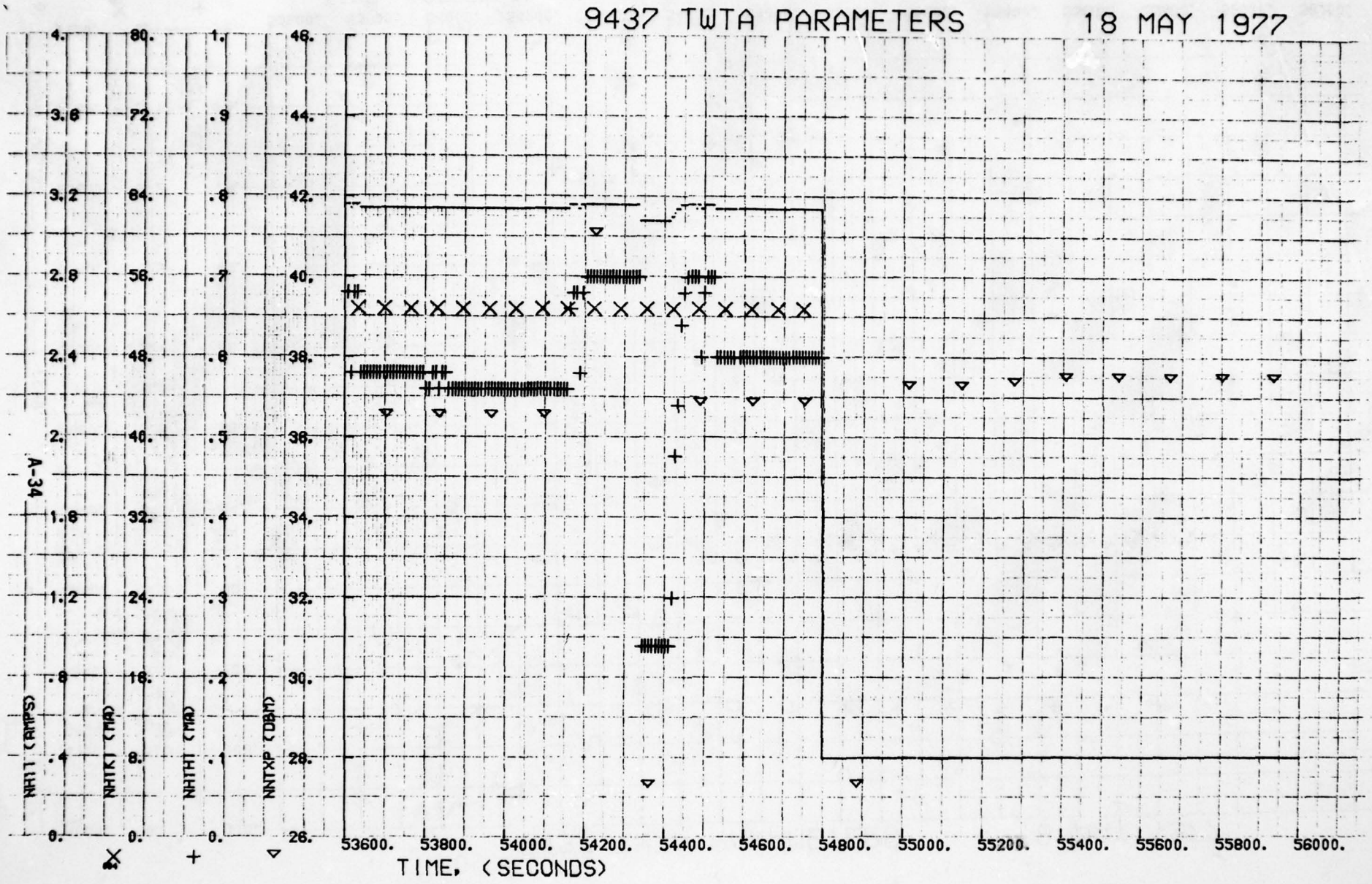

9437 TWTA PARAMETERS 13 MAY 1977
EHTAV (VOLTS)
EHTFD (VOLTS)
EHTT (DEG F)
TIME, (SECONDS)
A-29

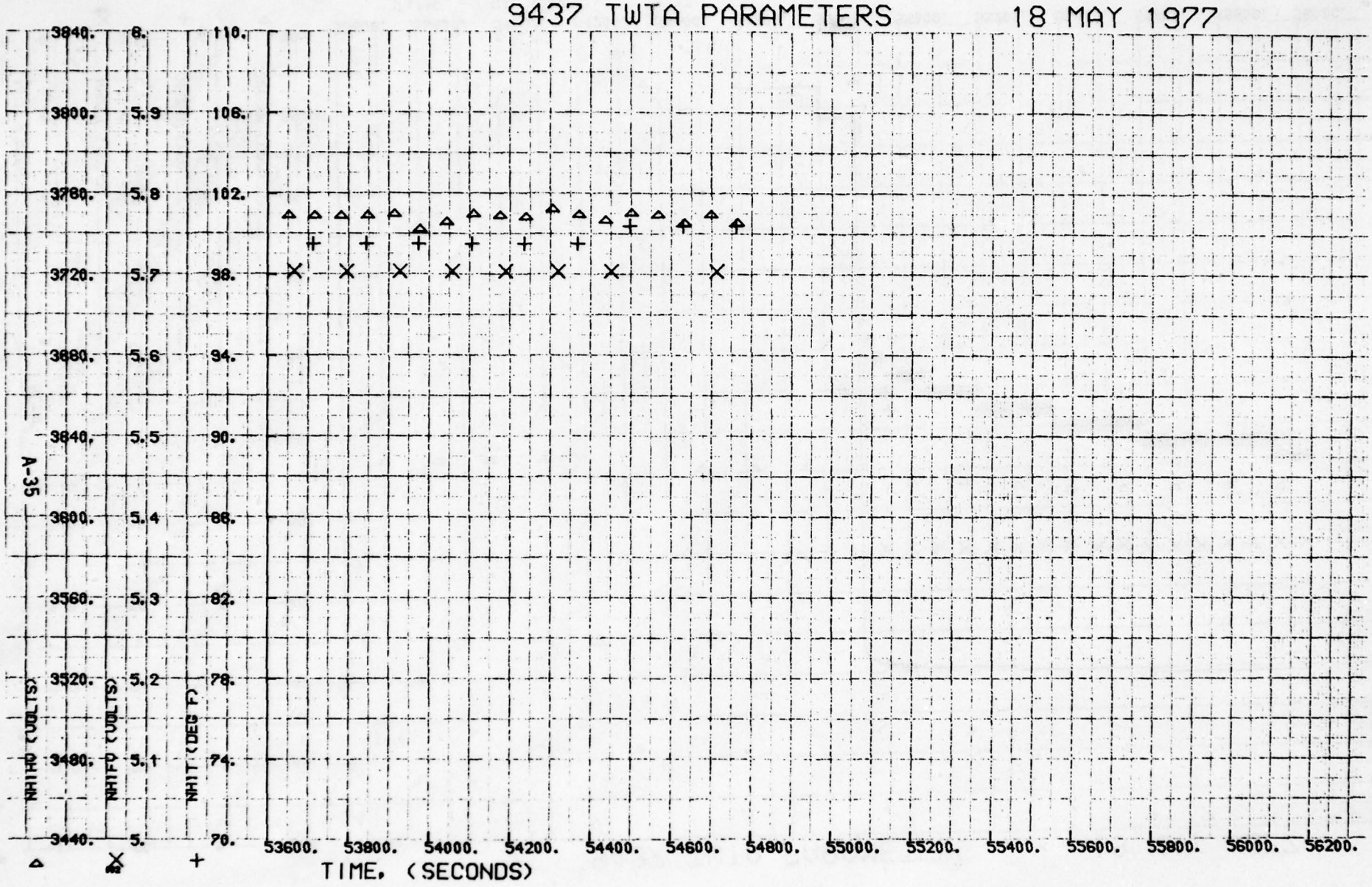

9437 TWTA PARAMETERS
18 MAY 1977
A-30
EHT (AMPS)
EHIK (MA)
EHIH (MA)
EETXP (DBM)
TIME, (SECONDS)
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.

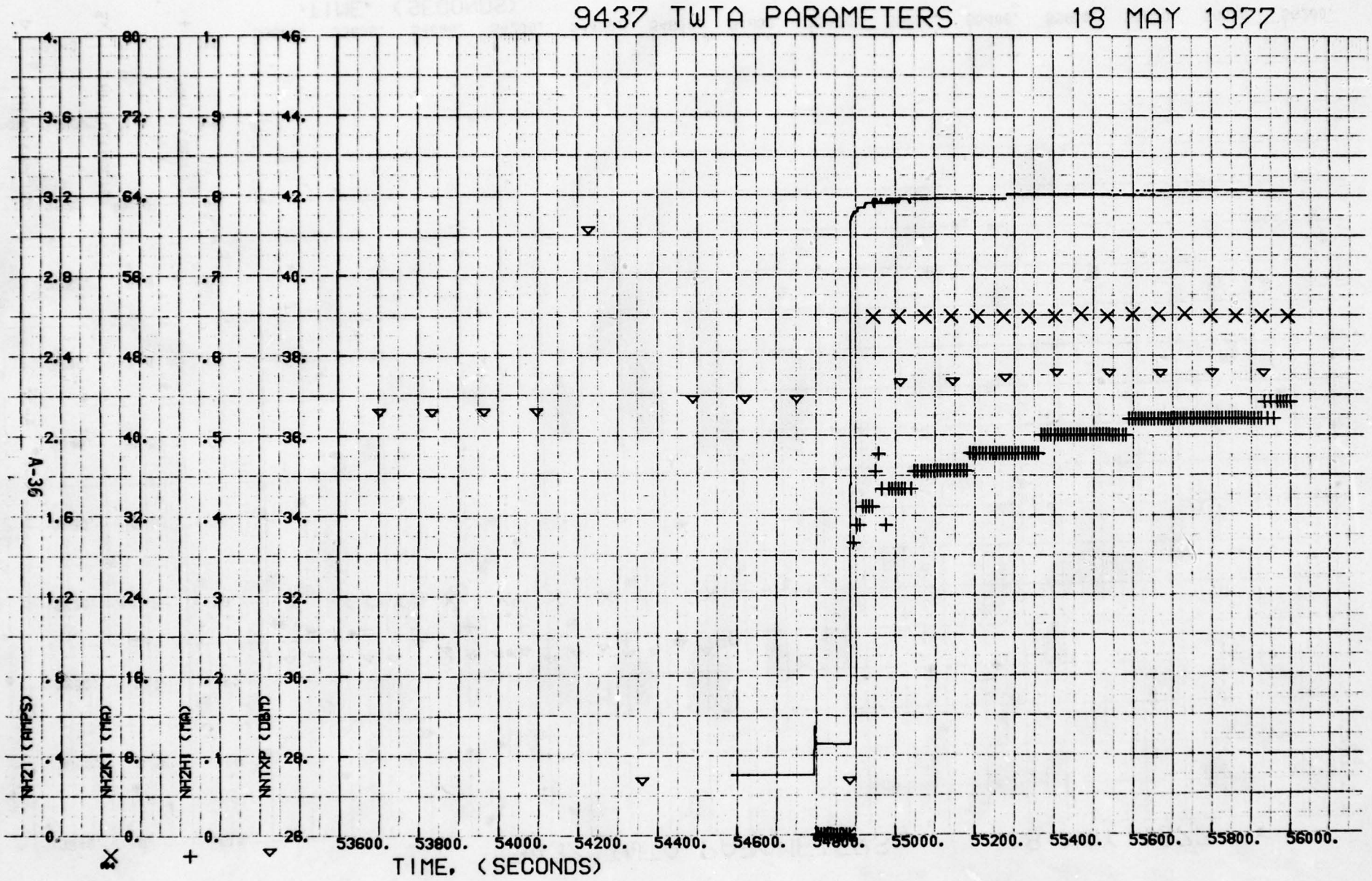

9437 TWTA PARAMETERS
18 MAY 1977
A-31
EHIHD (VOLTS)
EHIFD (VOLTS)
EHIT (DEG F)
4000.
3920.
3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.
56200.
TIME, (SECONDS)

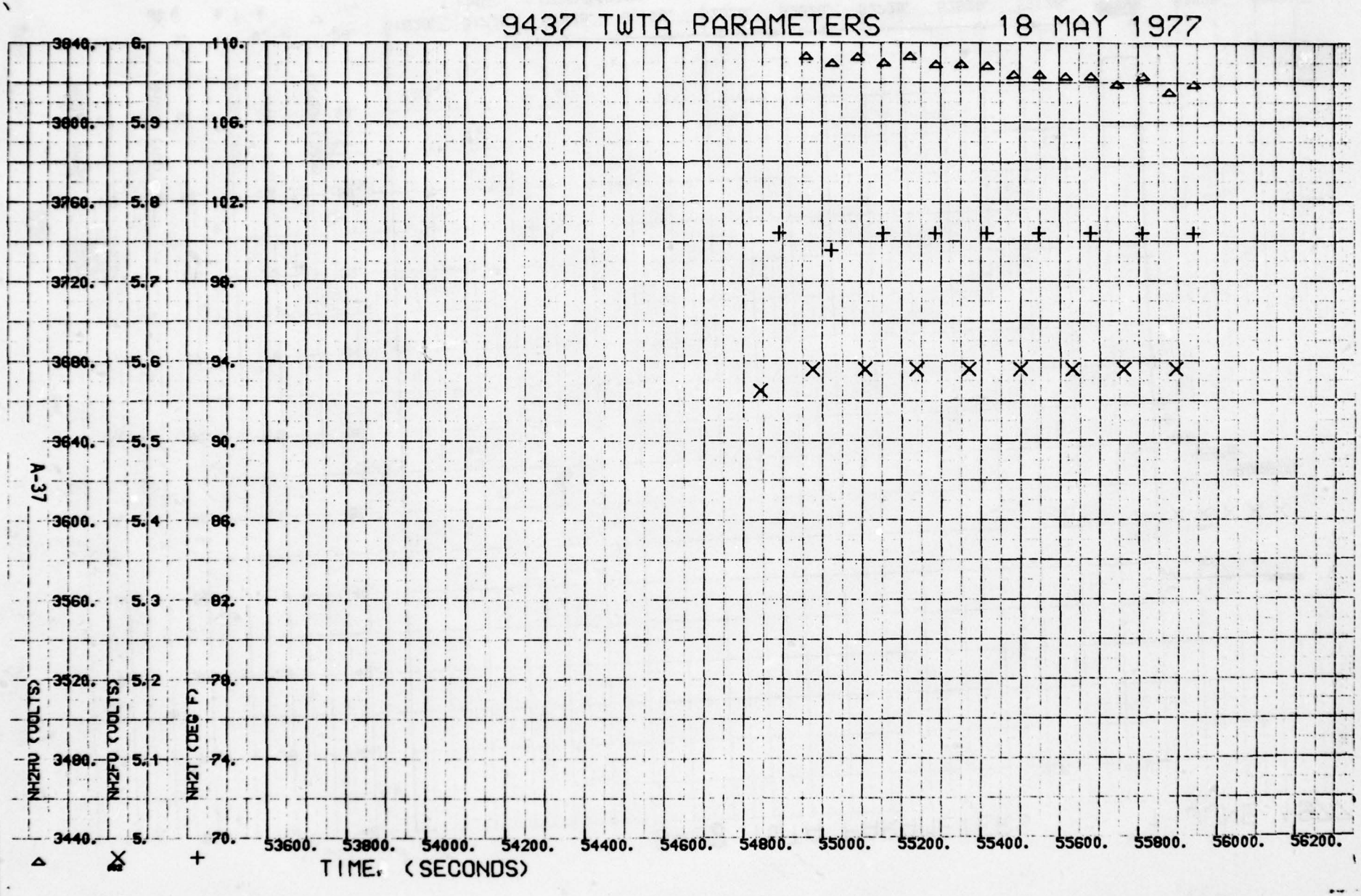

9437 TWTA PARAMETERS
18 MAY 1977
A-32
EHZI (AMPS)
EHZK (MA)
EHZH (MA)
EETXP (DBM)
TIME, (SECONDS)
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.

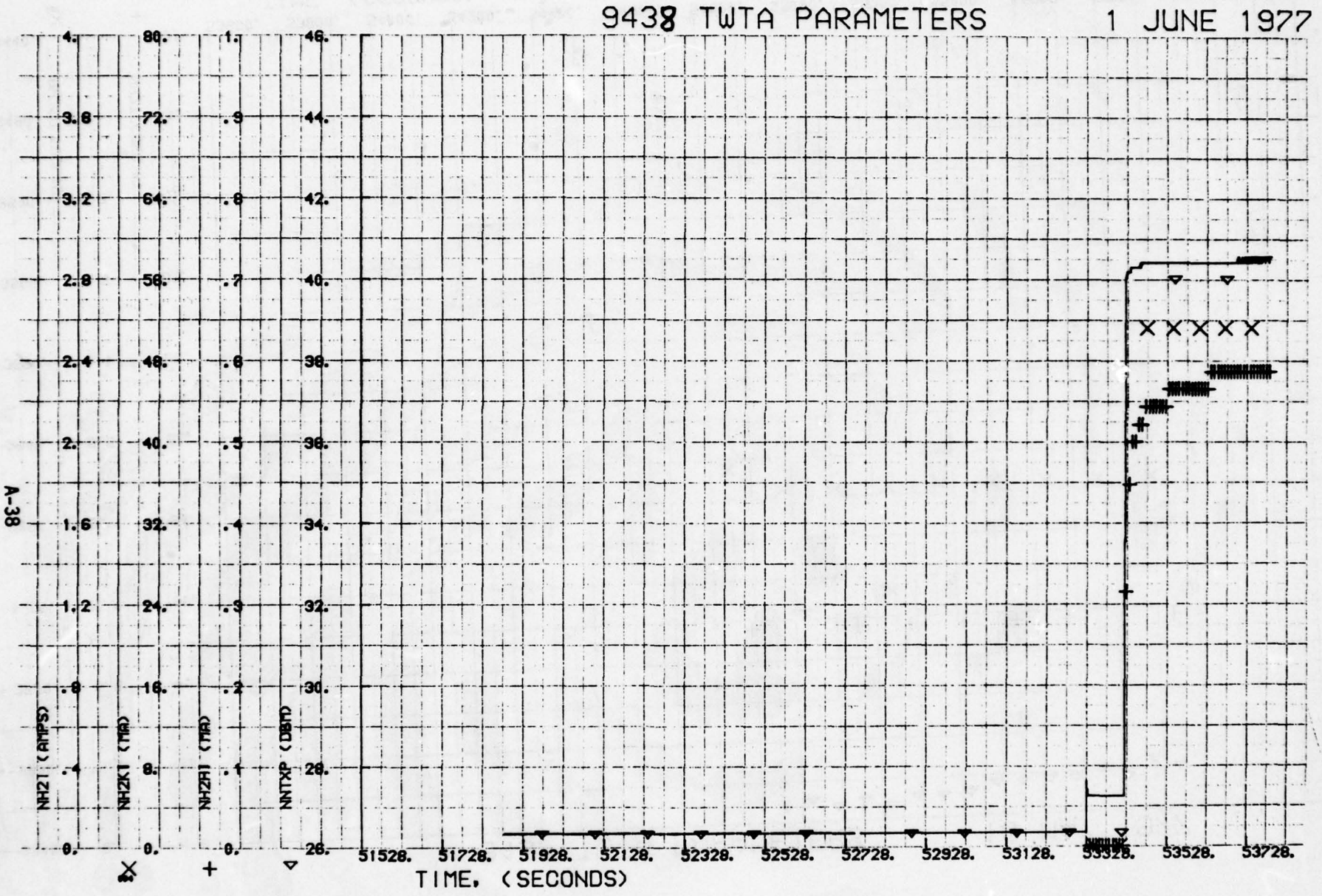

9437 TWTA PARAMETERS
18 MAY 1977
EH2HV (VOLTS)
EH2FV (VOLTS)
EH2T (DEG F)
TIME, (SECONDS)
4000.
3920.
3840.
3760.
3680.
3600.
3520.
3440.
3360.
3280.
3200.
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.
56200.

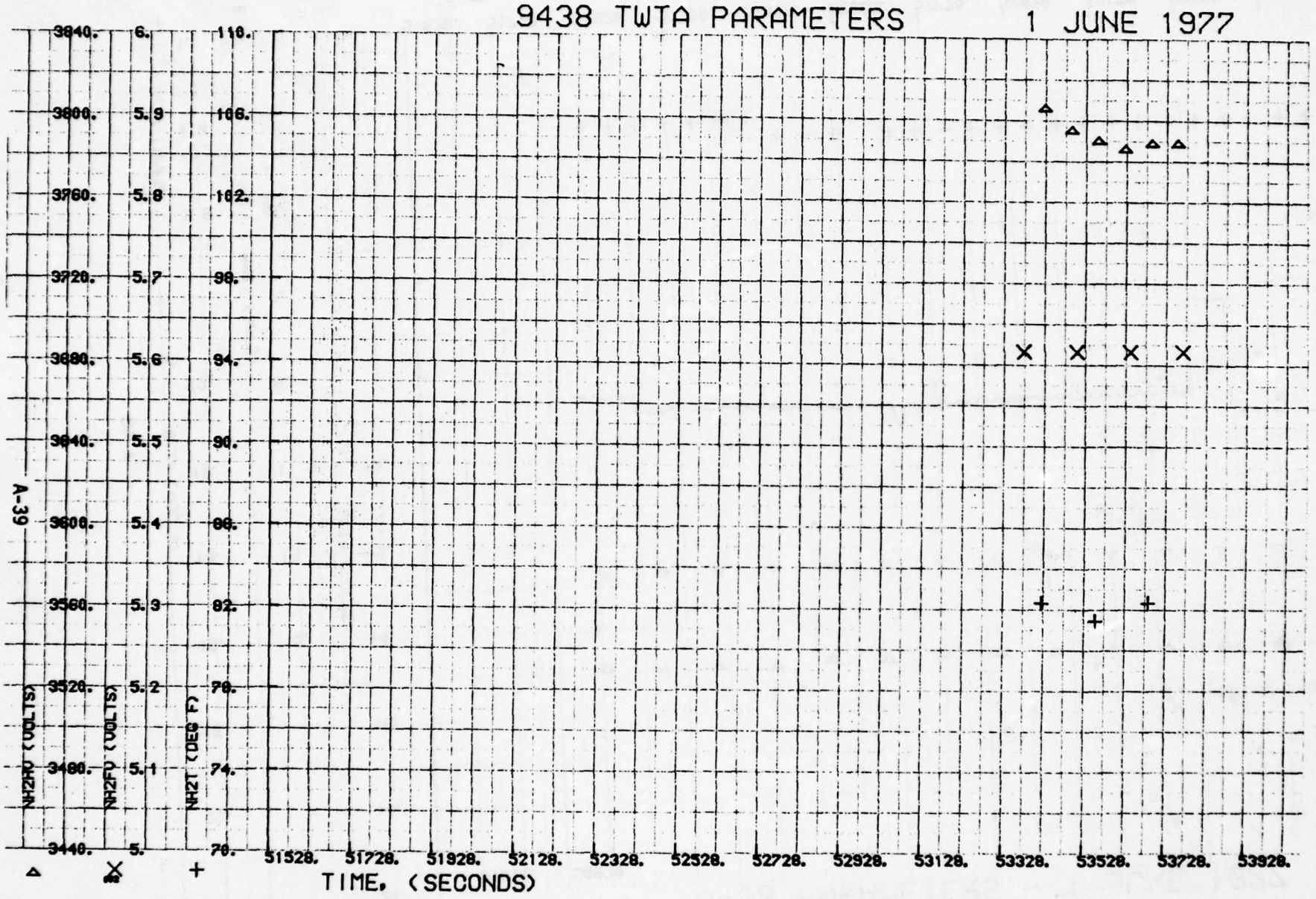

9437 TWTA PARAMETERS
18 MAY 1977
NH1I (AMPS)
NHIK (MA)
NHIHI (MA)
NHTXP (DBM)
TIME, (SECONDS)
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.

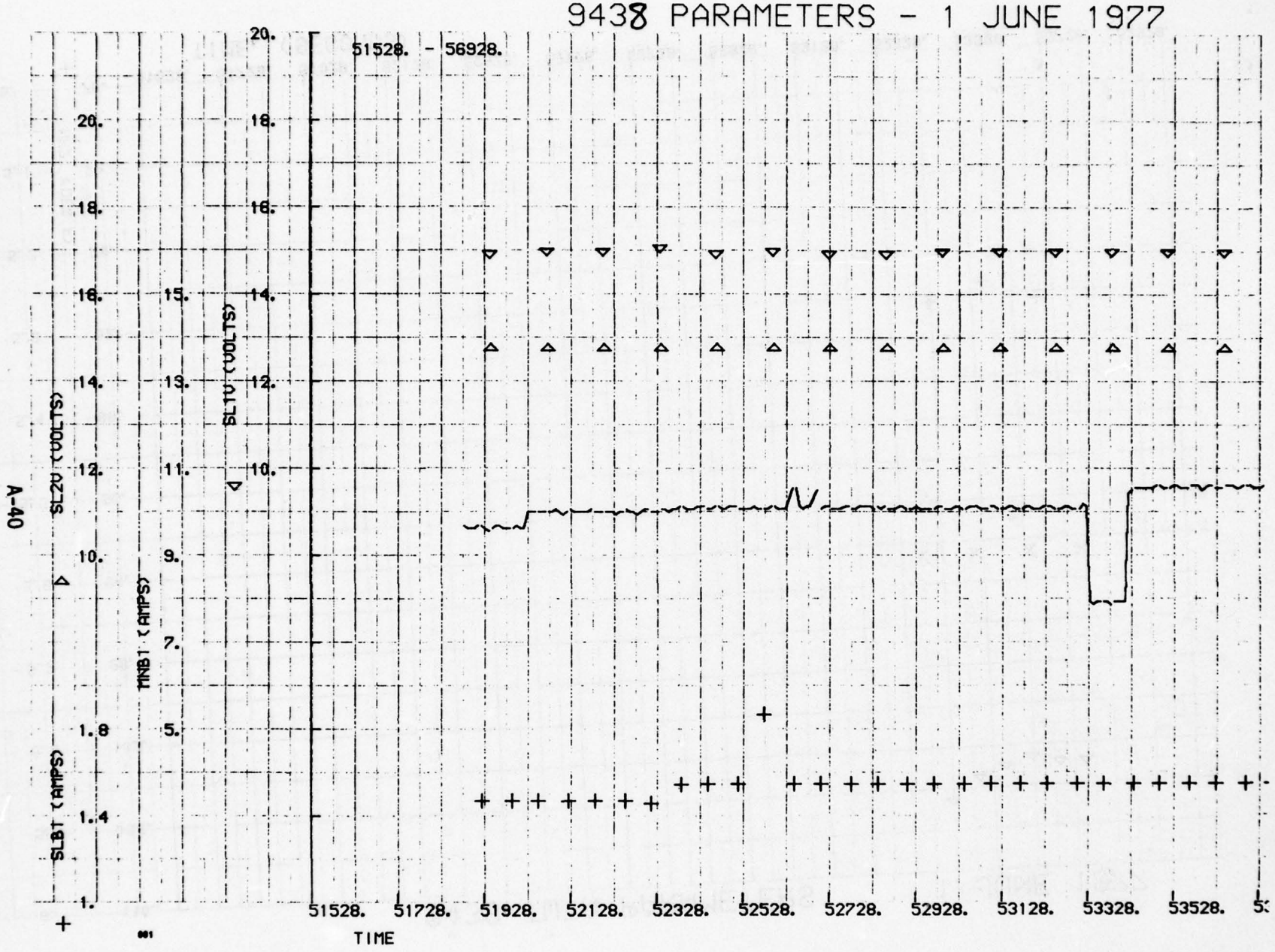

9437 TWTA PARAMETERS
18 MAY 1977
3840.
3800.
3760.
3720.
3680.
3640.
3600.
3560.
3520.
3480.
3440.
NHIHD (VOLTS)
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
NHIFD (VOLTS)
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
NHIT (DEG F)
53600.
53800.
54000.
54200.
54400.
54600.
54800.
55000.
55200.
55400.
55600.
55800.
56000.
56200.
TIME, (SECONDS)
A-35


9437 TWTA PARAMETERS
18 MAY 1977
NHZI (AMPS)
NHZK1 (MA)
NHZH1 (MA)
NNTXP (DBM)
TIME, (SECONDS)
53600.
53800.
54000.
54200.
54400.
54600.
55000.
55200.
55400.
55600.
55800.
56000.


9437 TWTA PARAMETERS 18 MAY 1977
3840. 6. 110.
3800. 5.9 106.
3760. 5.8 102.
3720. 5.7 98.
3680. 5.6 94.
3640. 5.5 90.
3600. 5.4 86.
3560. 5.3 82.
3520. 5.2 78.
3480. 5.1 74.
3440. 5. 70.
NH2HU (VOLTS)
NH2FU (VOLTS)
NH2T (DEG F)
53600. 53800. 54000. 54200. 54400. 54600. 54800. 55000. 55200. 55400. 55600. 55800. 56000. 56200.
TIME, (SECONDS)

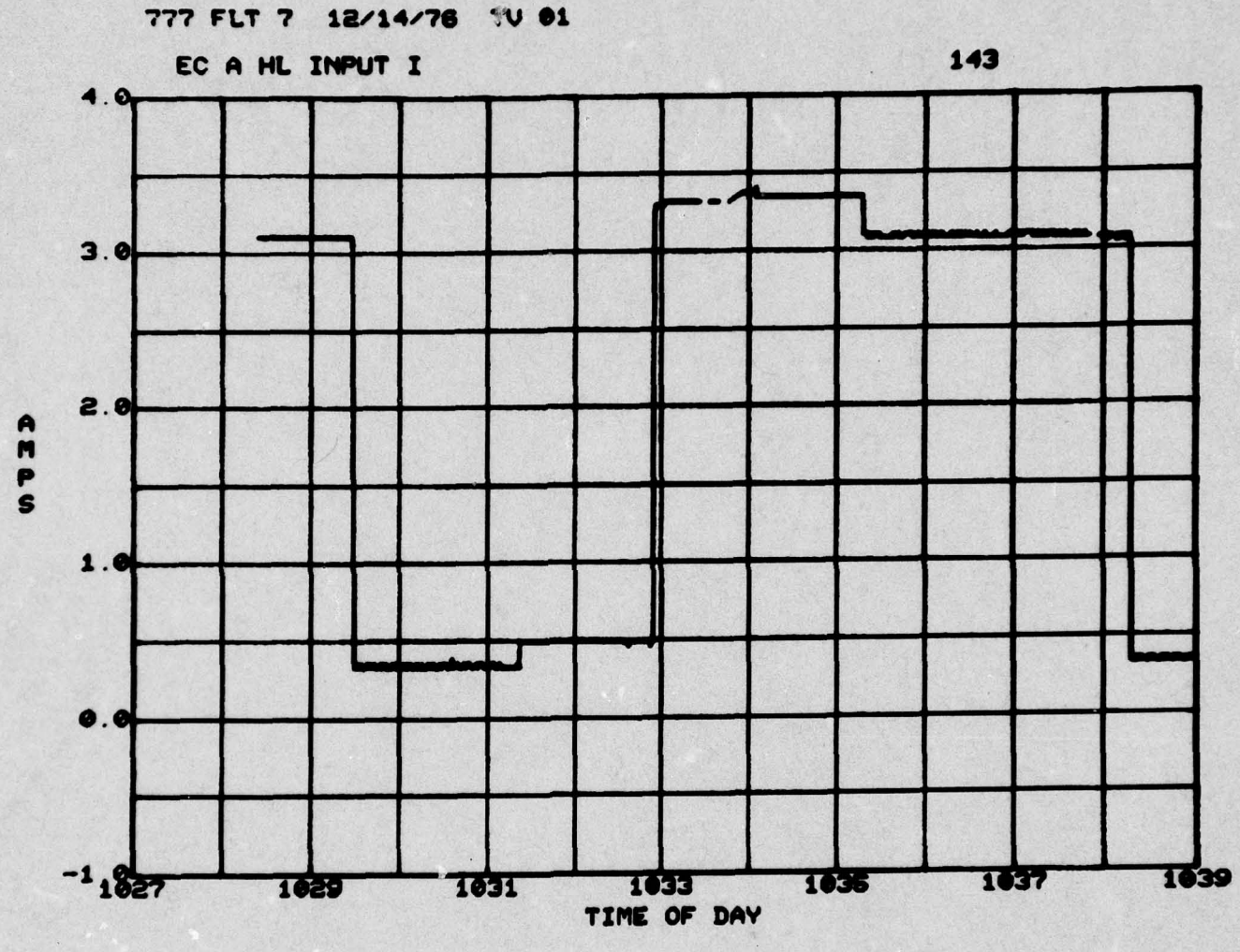

9438 TWTA PARAMETERS
1 JUNE 1977
NH2I (AMPS)
NH2K1 (MA)
NH2H1 (MA)
NNTXP (DBM)
TIME, (SECONDS)
51528.
51728.
51928.
52128.
52328.
52528.
52728.
52928.
53128.
53328.
53528.
53728.

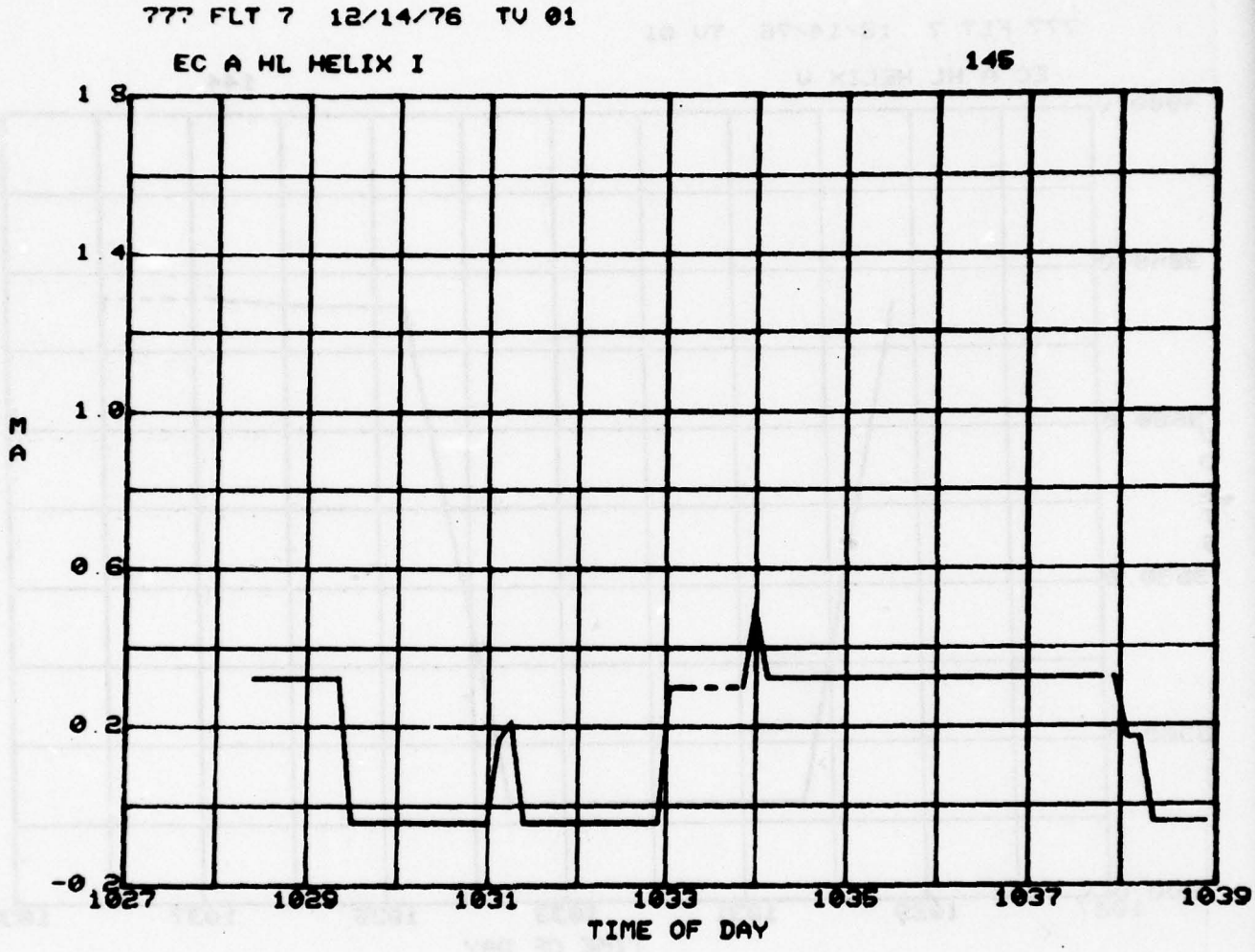

9438 TWTA PARAMETERS
1 JUNE 1977
3840.
3800.
3760.
3720.
3680.
3640.
3600.
3560.
3520.
3480.
3440.
NH2HV (VOLTS)
6.
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
5.
NH2FV (VOLTS)
110.
106.
102.
98.
94.
90.
86.
82.
78.
74.
70.
NH2T (DEG F)
51528.
51728.
51928.
52128.
52328.
52528.
52728.
52928.
53128.
53328.
53528.
53728.
53928.
TIME, (SECONDS)
A-39

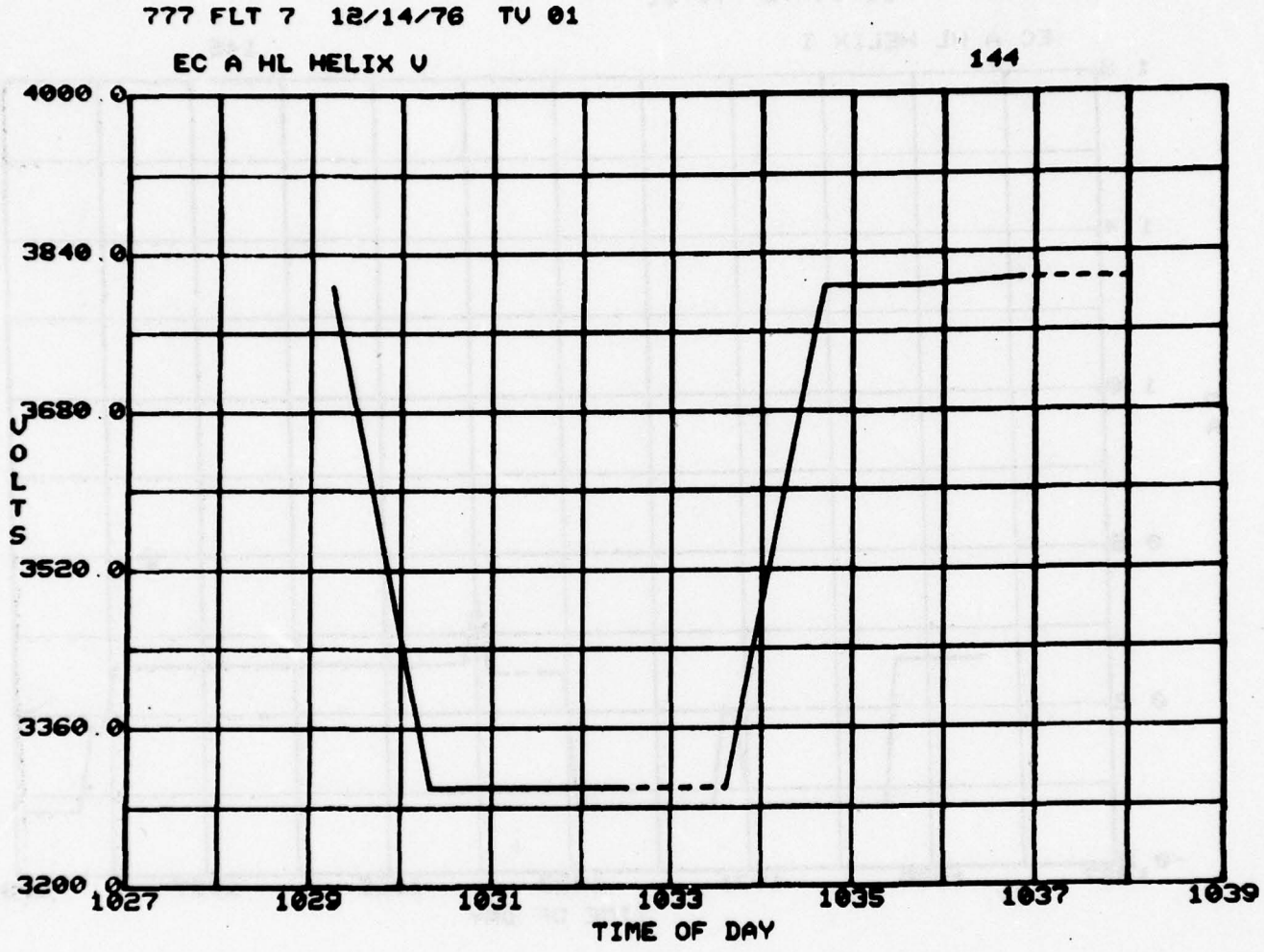

9438 PARAMETERS - 1 JUNE 1977
51528. - 56928.
SL2V (VOLTS)
SLTV (VOLTS)
MNBI (AMPS)
SLBI (AMPS)
TIME
51528.
51728.
51928.
52128.
52328.
52528.
52728.
52928.
53128.
53328.
53528.
A-40

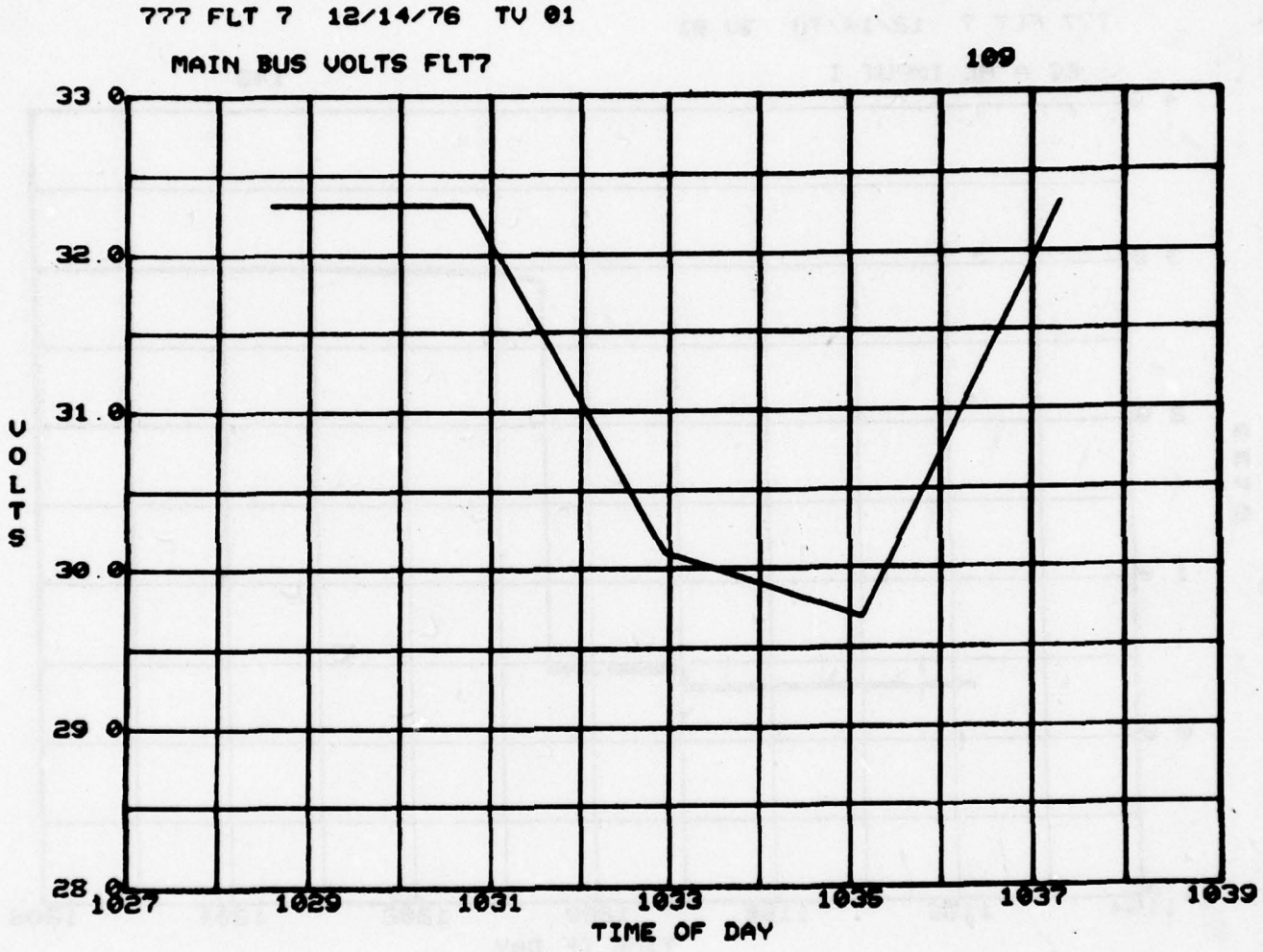
APPENDIX A-4

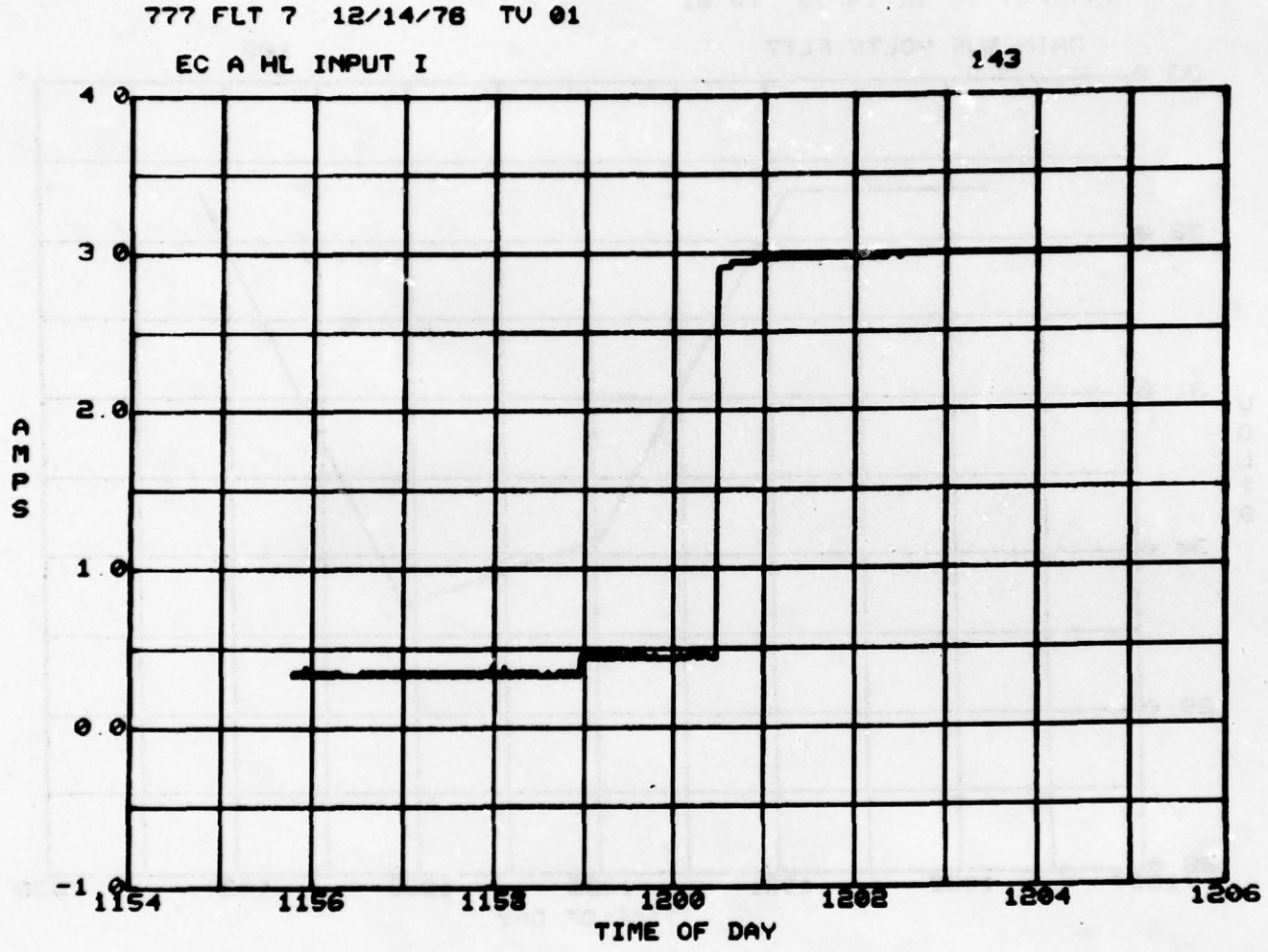
F7 AND F8 TELEMETRY PARAMETERS AT TURN ON DURING SELECTED GROUND TEST

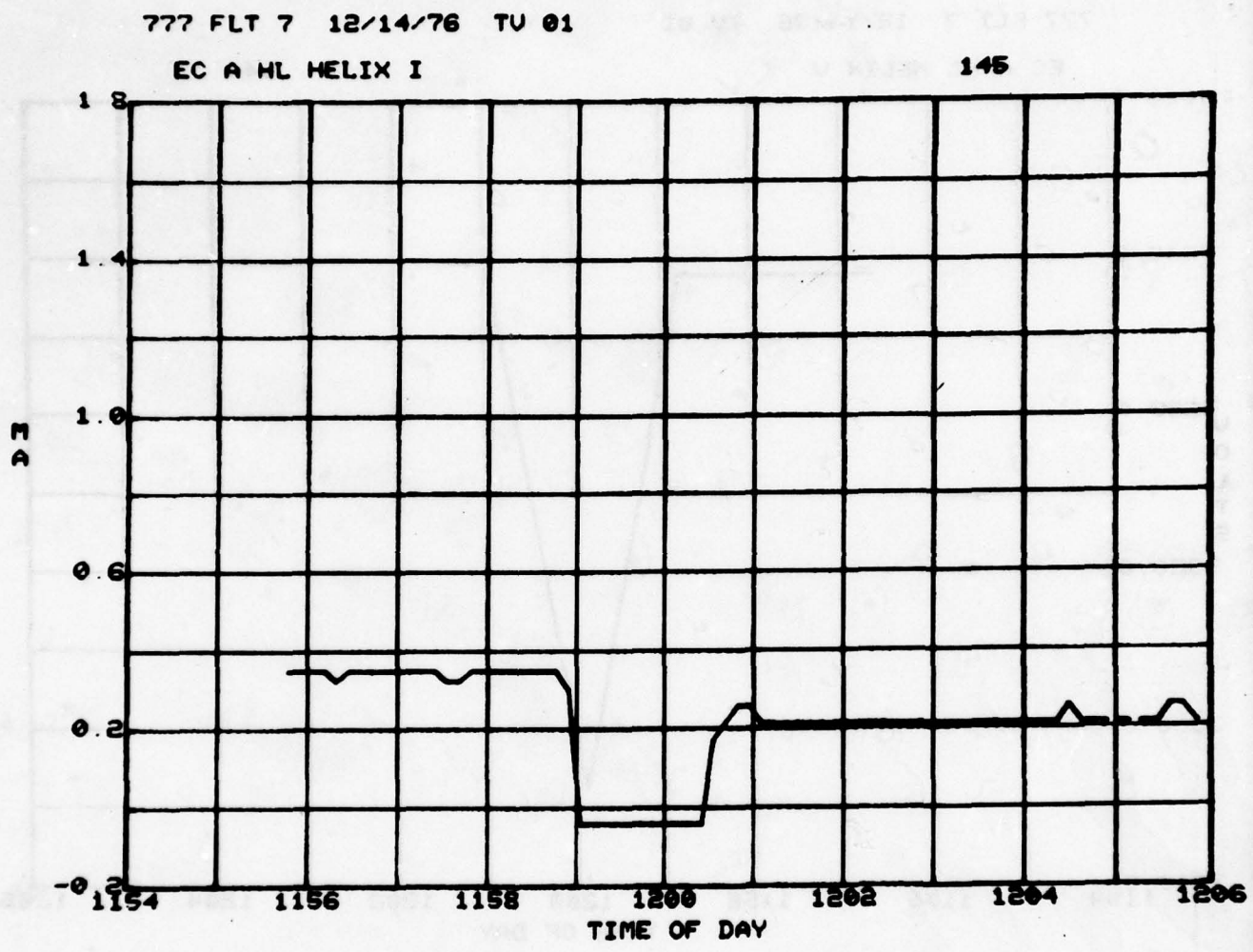

777 FLT 7 12/14/76 SV 01
EC A HL INPUT I
143
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1027
1029
1031
1033
1035
1037
1039
TIME OF DAY

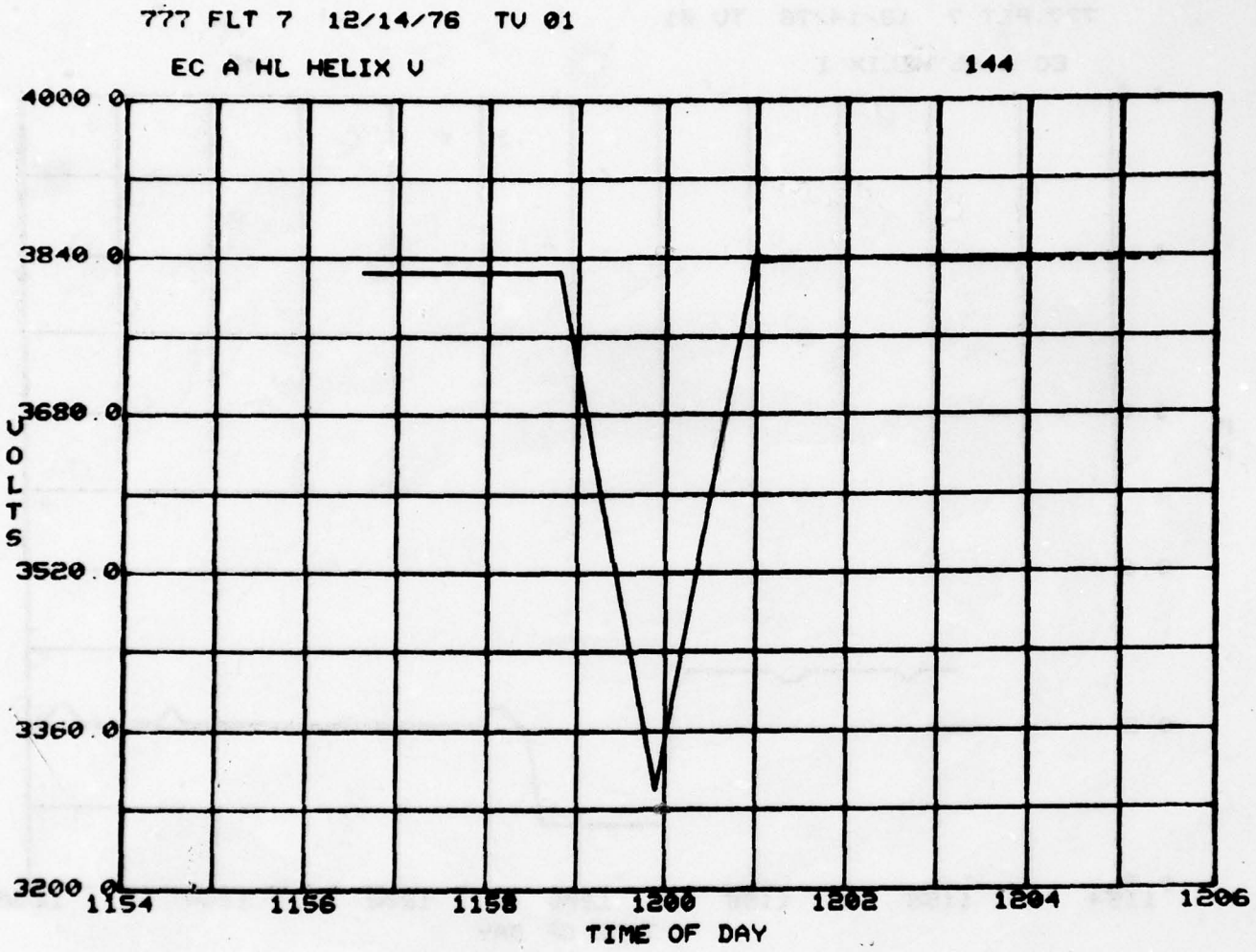

777 FLT 7 12/14/76 TU 01
EC A HL HELIX I
145
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1027
1029
1031
1033
1035
1037
1039
TIME OF DAY

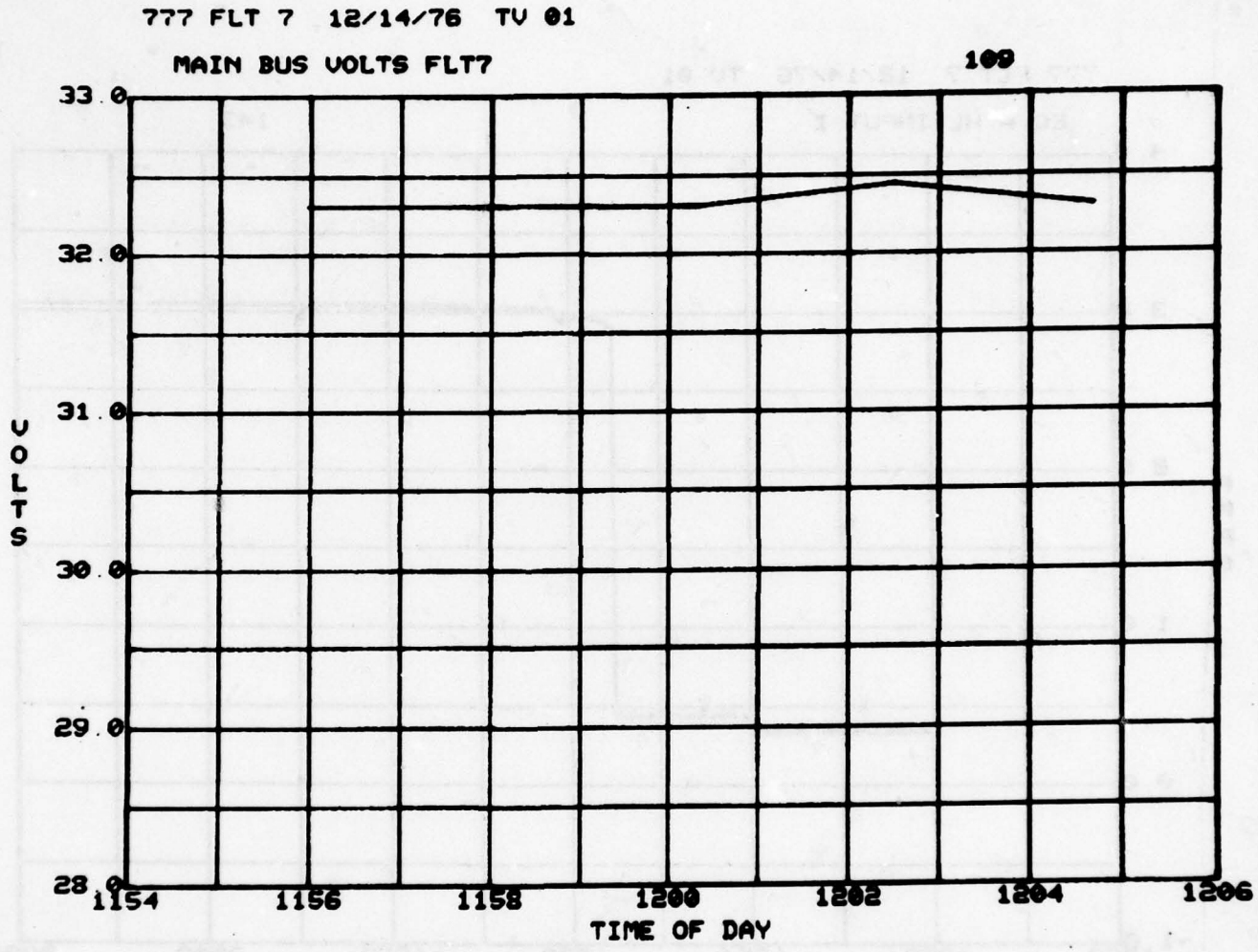

777 FLT 7 12/14/76 TV 01
EC A HL HELIX V
144
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1027
1029
1031
1033
1035
1037
1039
TIME OF DAY

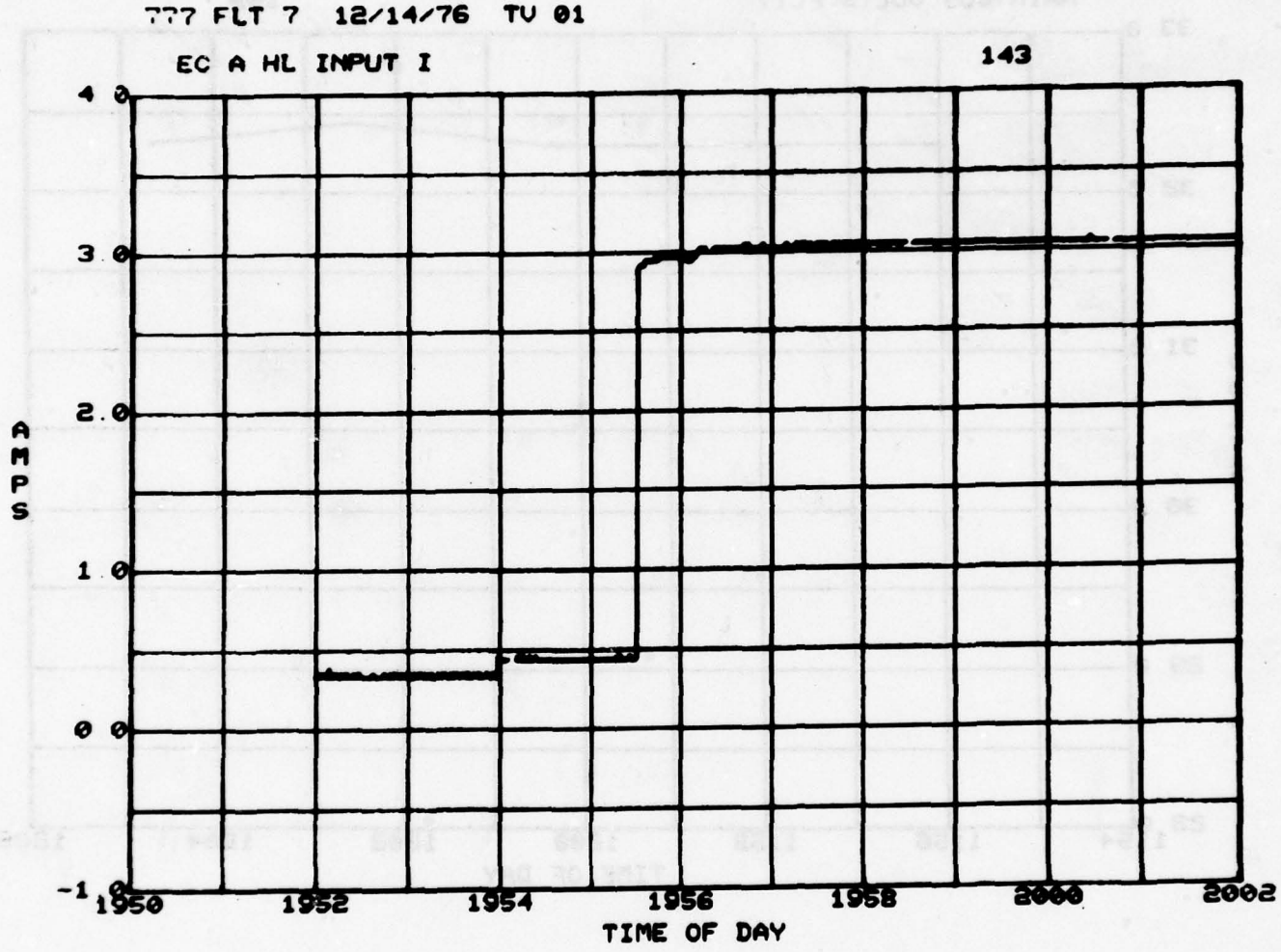

777 FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
109
33 0
32.0
31.0
30.0
29 0
28 0
VOLTS
1027
1029
1031
1033
1035
1037
1039
TIME OF DAY

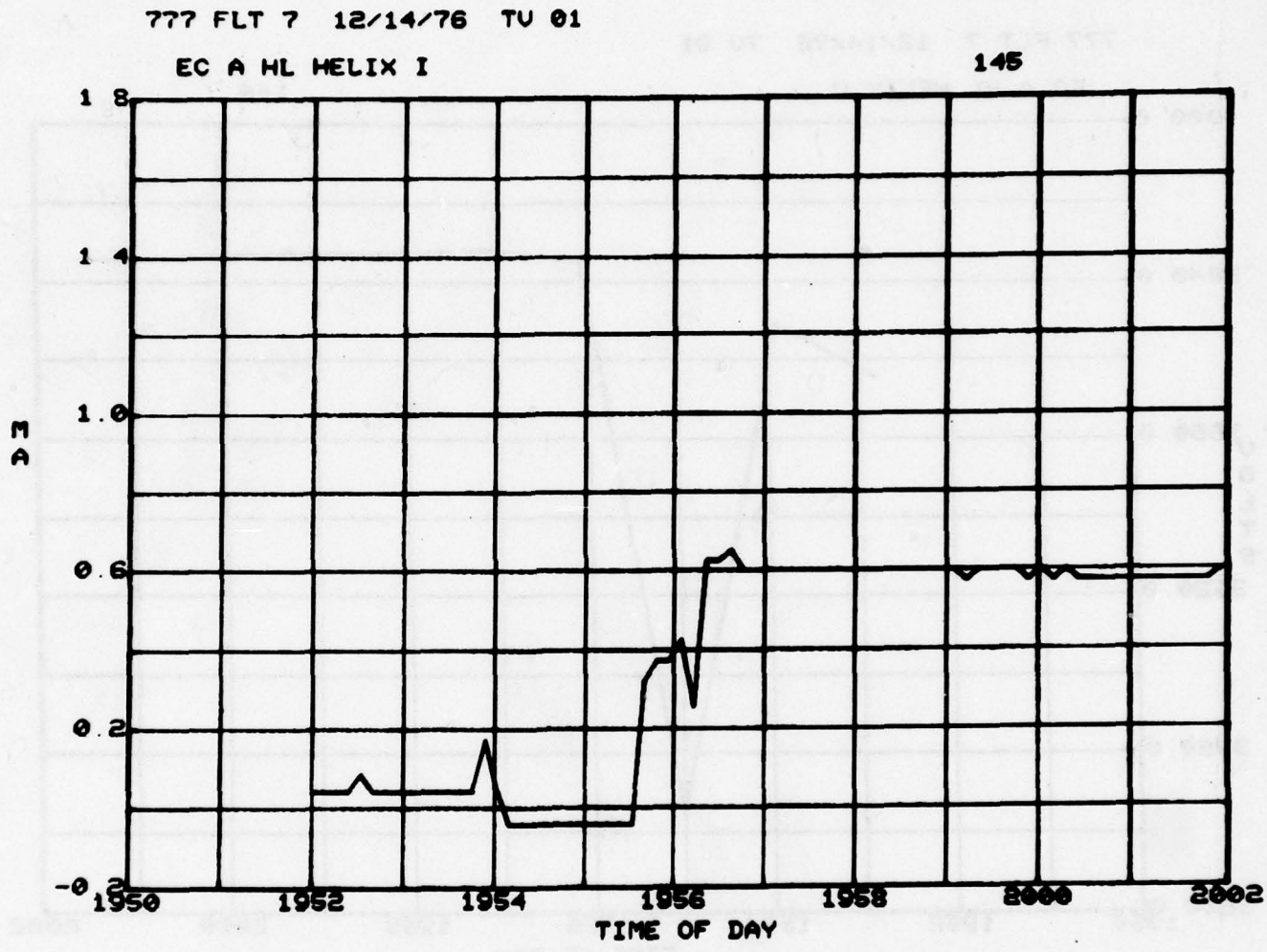

777 FLT 7 12/14/78 TV 01
EC A HL INPUT I
143
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1154
1156
1158
1200
1202
1204
1206
TIME OF DAY

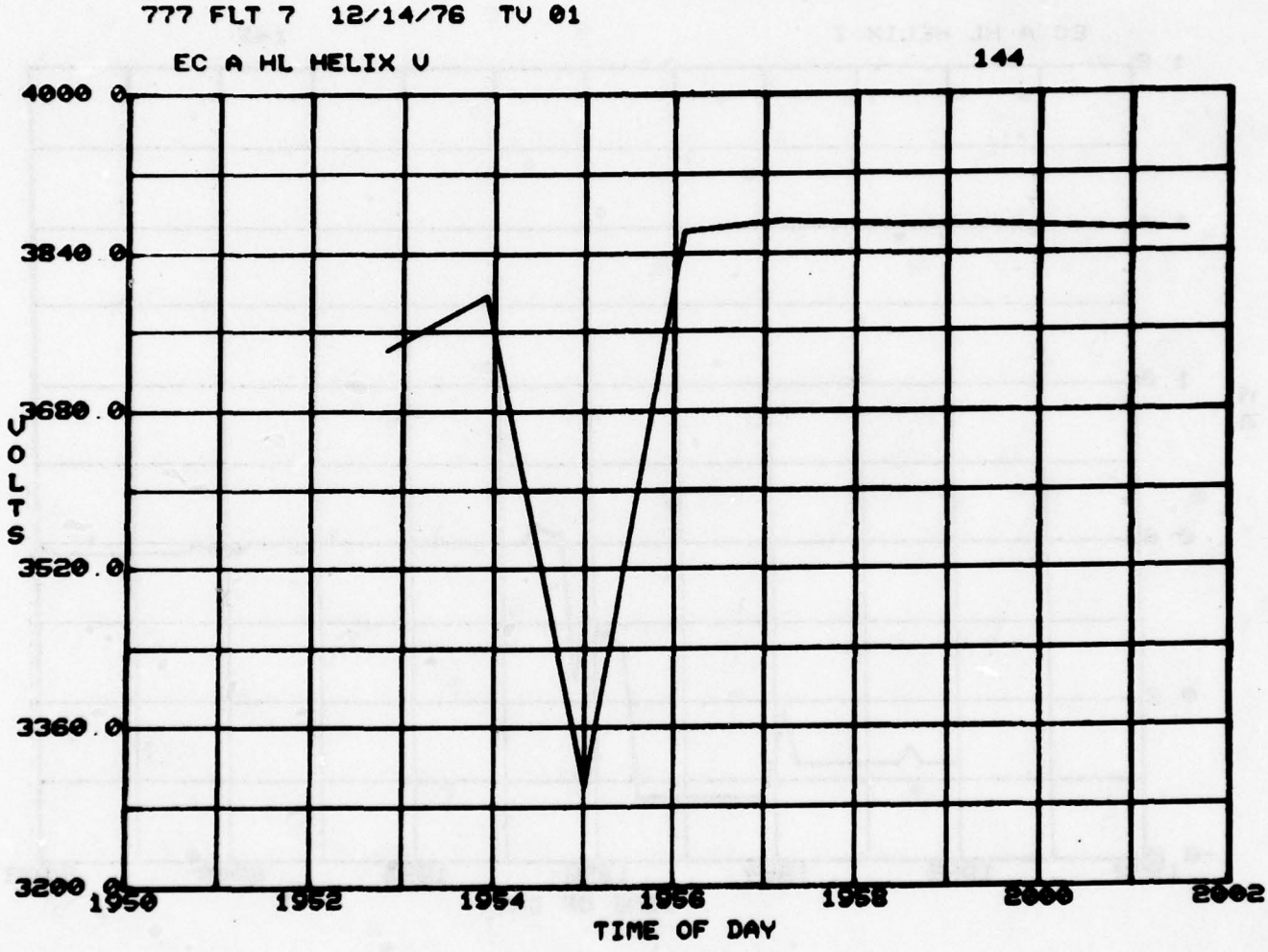

777 FLT 7 12/14/76 TV 01
EC A HL HELIX I
145
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1154
1156
1158
1200
1202
1204
1206
TIME OF DAY

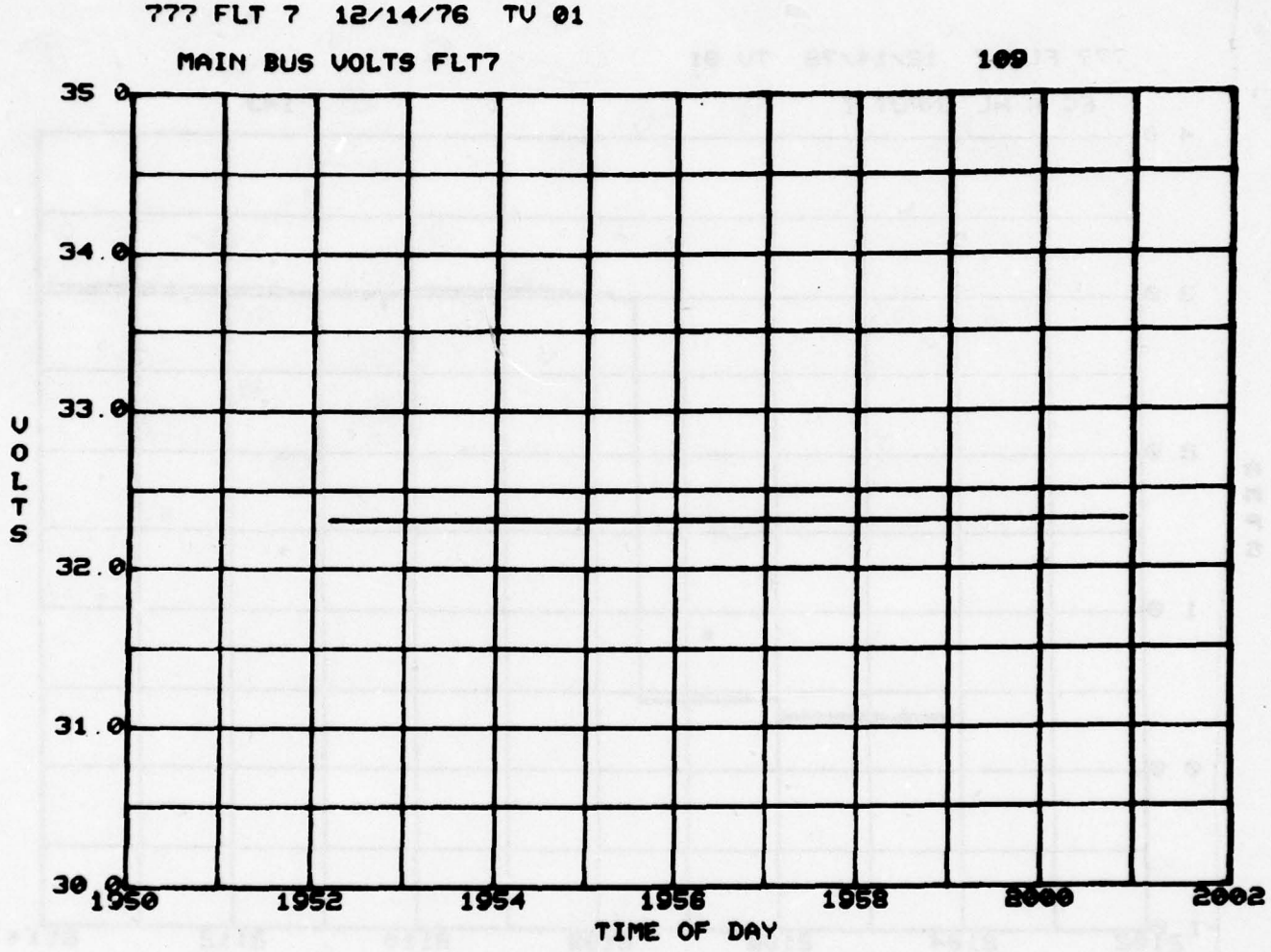

777 FLT 7 12/14/76 TV 01
EC A HL HELIX V
144
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1154
1156
1158
1200
1202
1204
1206
TIME OF DAY


777 FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
100
33.0
32.0
31.0
30.0
29.0
28.0
VOLTS
1154
1156
1158
1200
1202
1204
1206
TIME OF DAY


777 FLT 7 12/14/76 TU 01
EC A HL INPUT I
143
4 0
3 0
2.0
1 0
0 0
-1 0
AMPS
1950
1952
1954
1956
1958
2000
2002
TIME OF DAY


777 FLT 7 12/14/76 TU 01
EC A HL HELIX I
145
1 8
1 4
1.0
0.6
0.2
-0.2
MA
1950
1952
1954
1956
1958
2000
2002
TIME OF DAY


777 FLT 7 12/14/76 TV 01
EC A HL HELIX V
144
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1950
1952
1954
1956
1958
2000
2002
TIME OF DAY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VOLTS
1950
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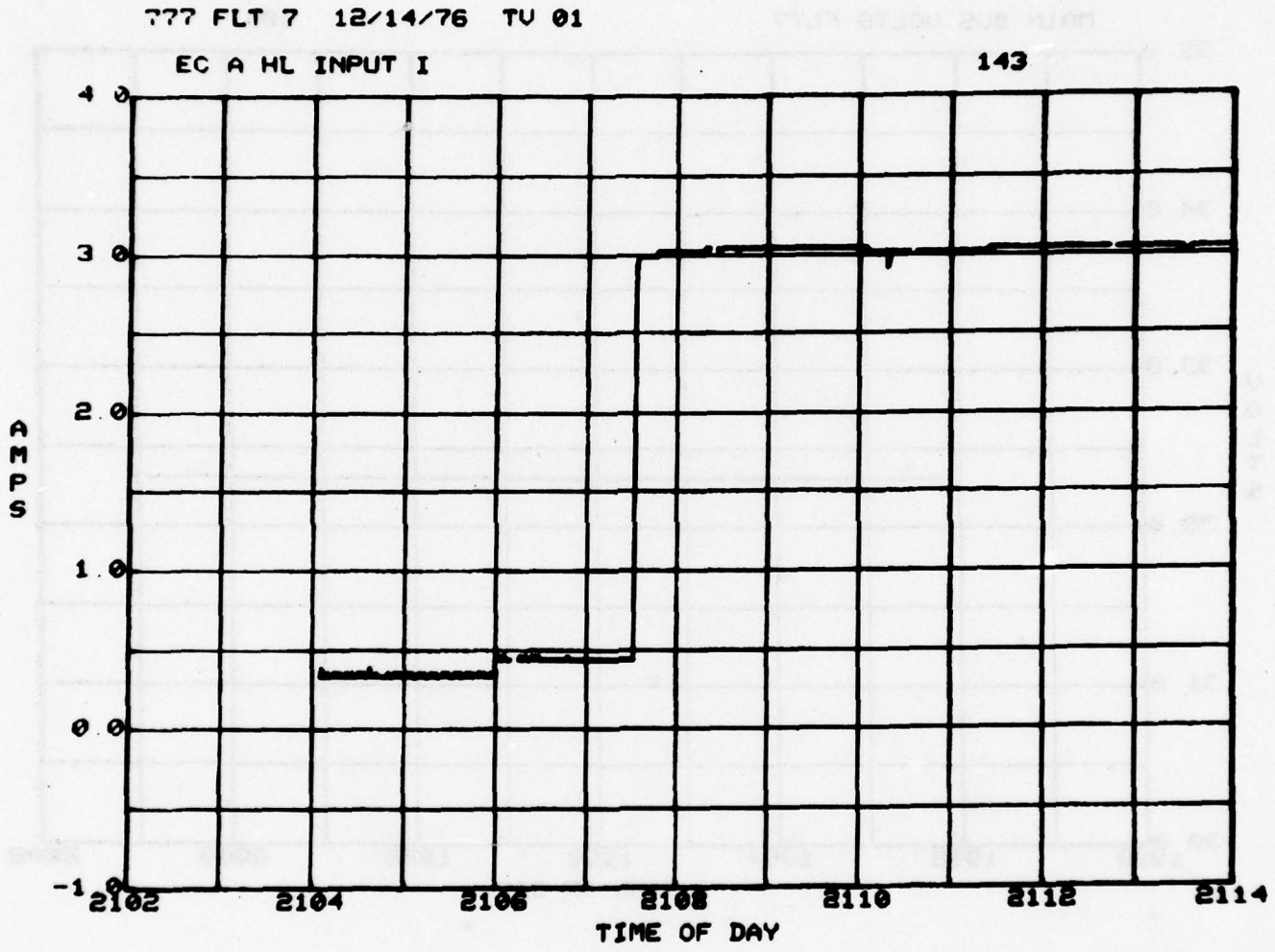
1958
2000
2002
TIME OF DAY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AMPS
2102
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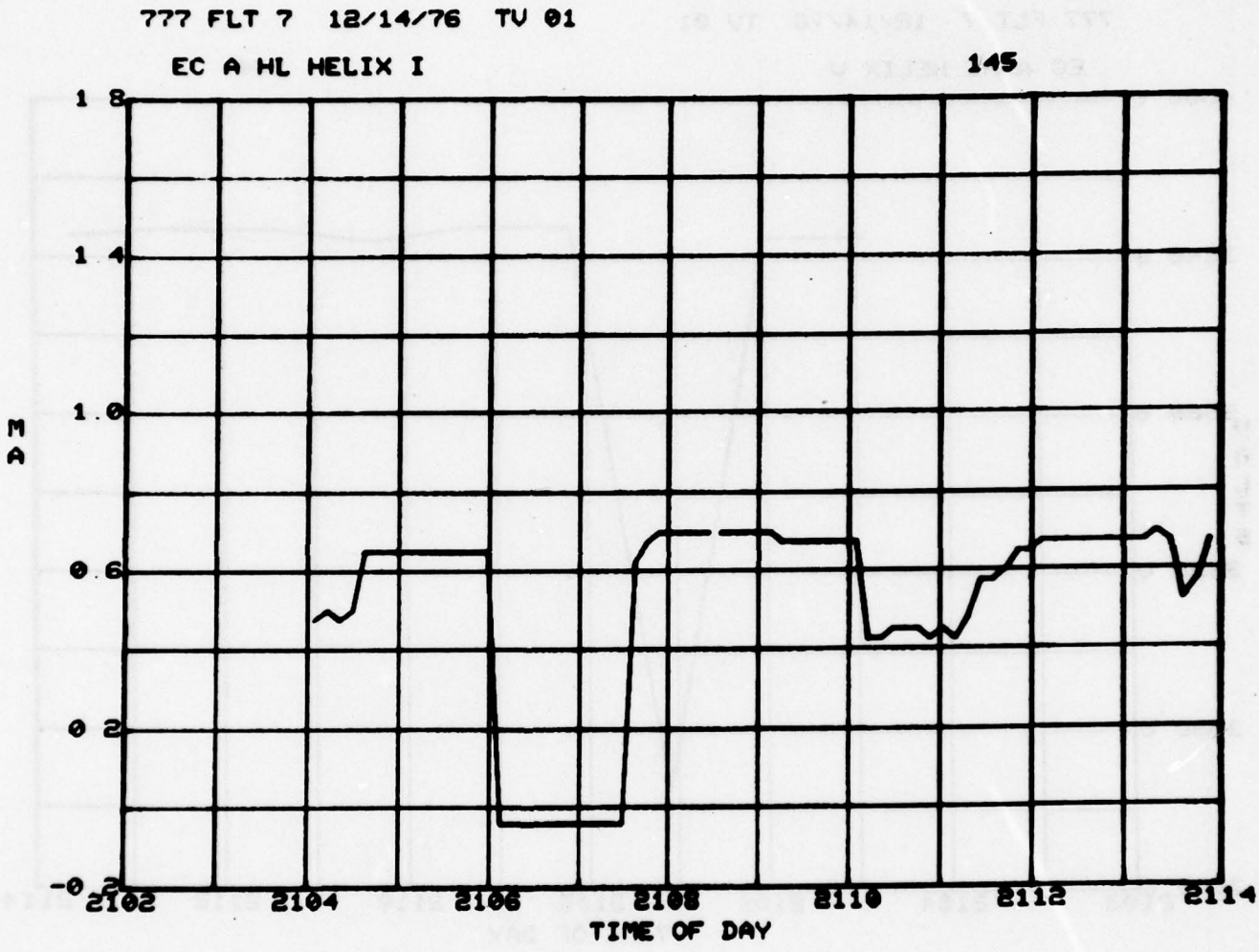
2114
TIME OF DAY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A
2102
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2112
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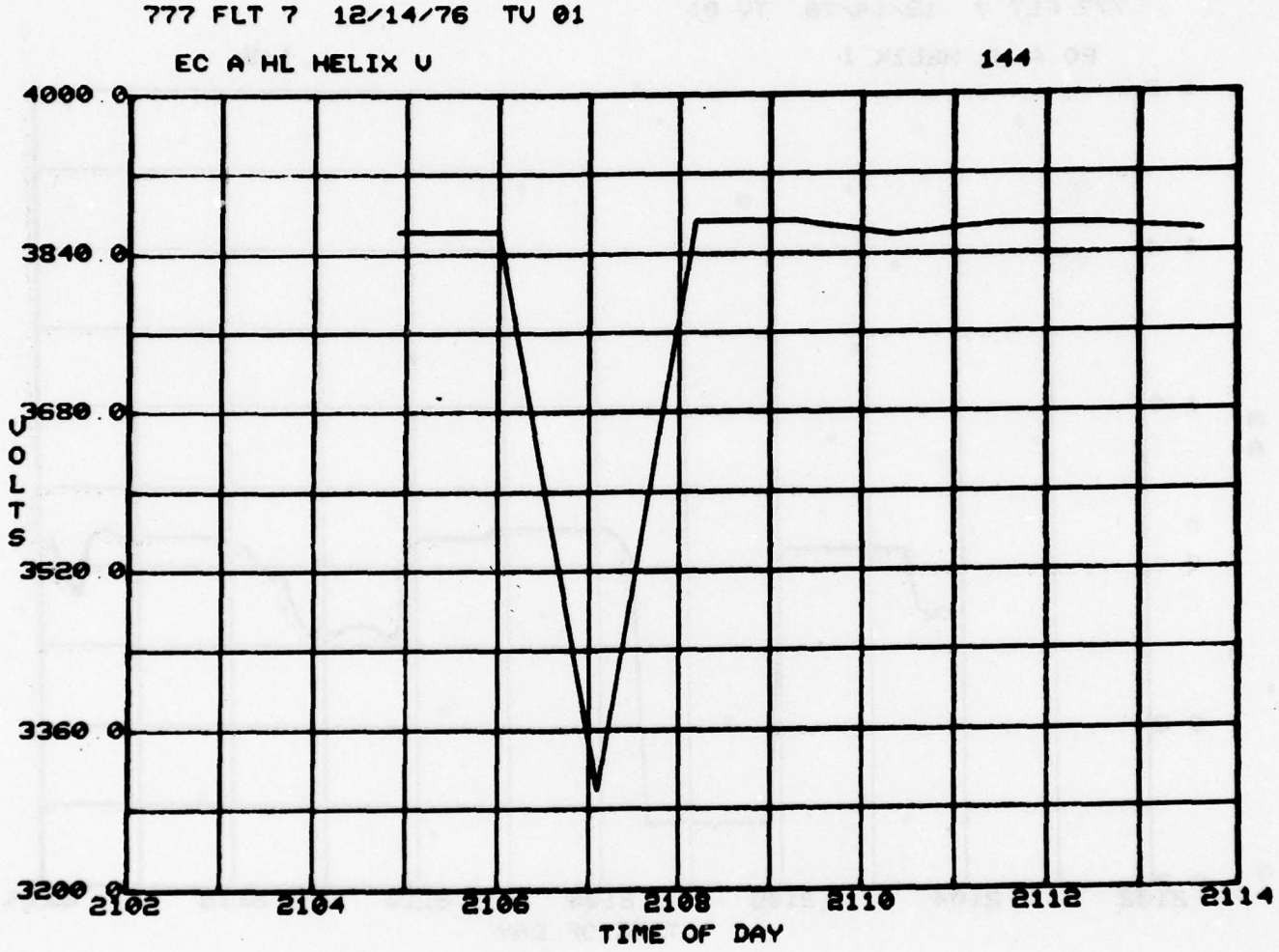
TIME OF DAY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2102
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2108
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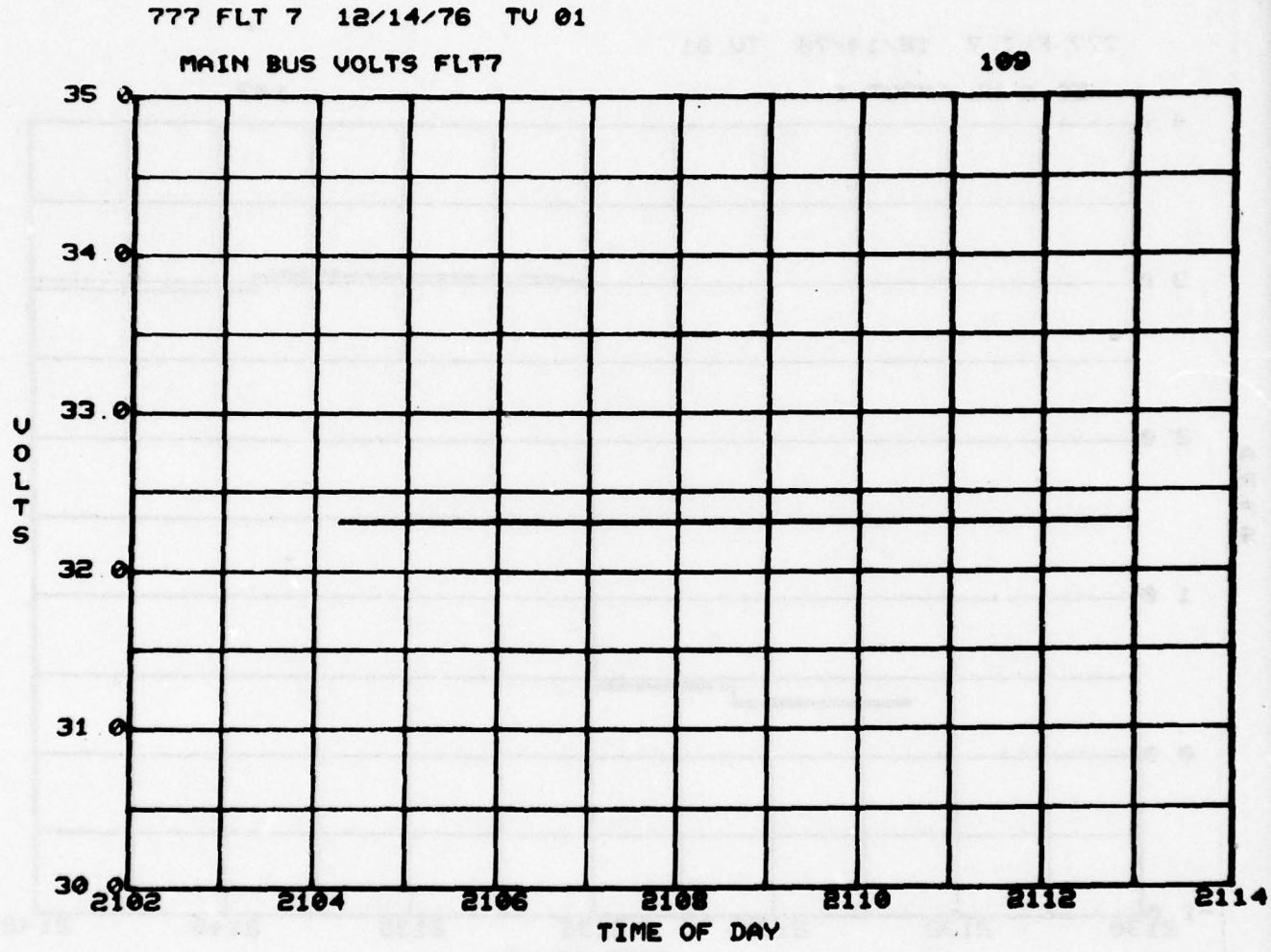
2112
2114
TIME OF DAY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MAIN BUS VOLTS FLT7
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2112
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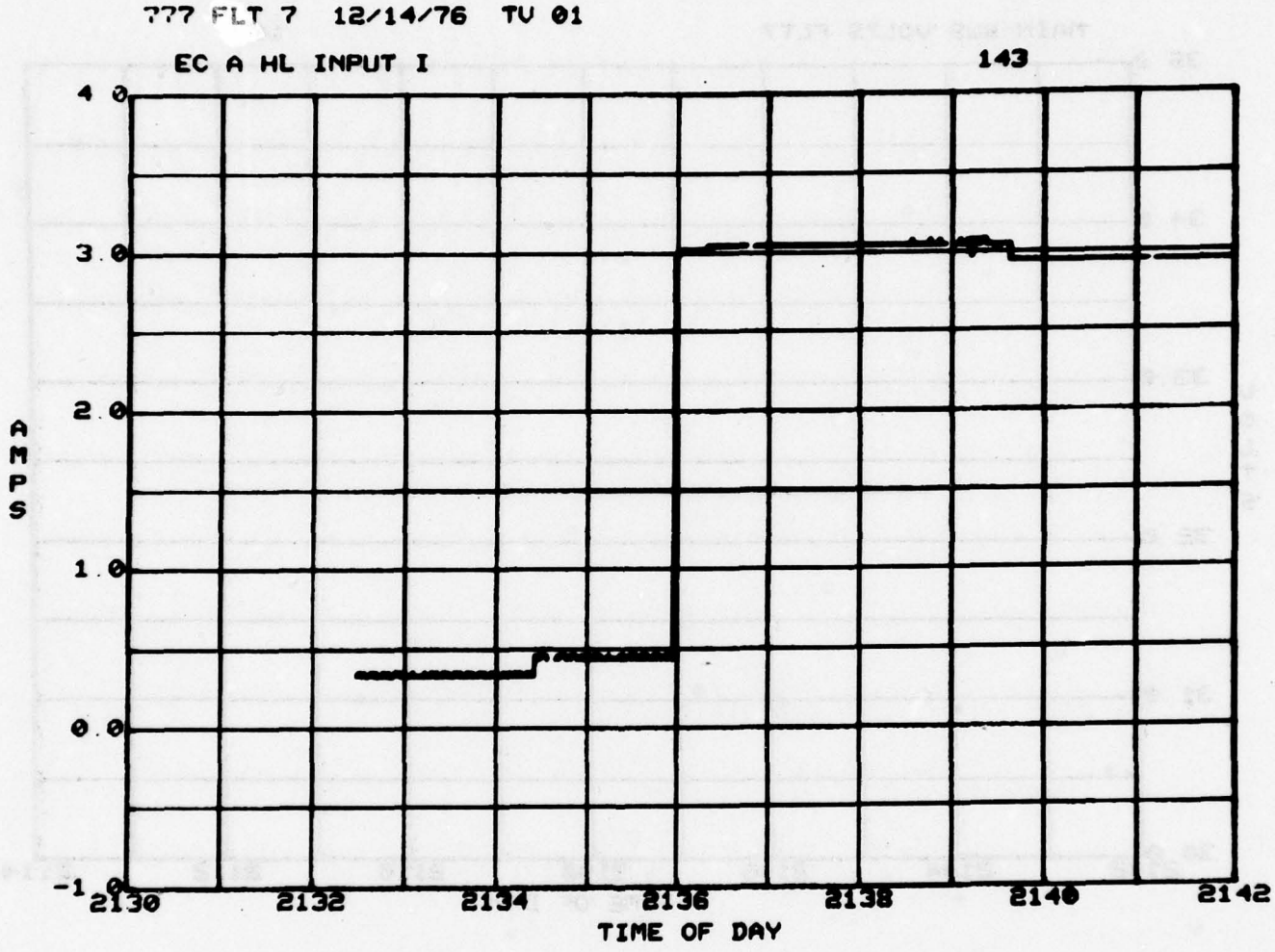
TIME OF DAY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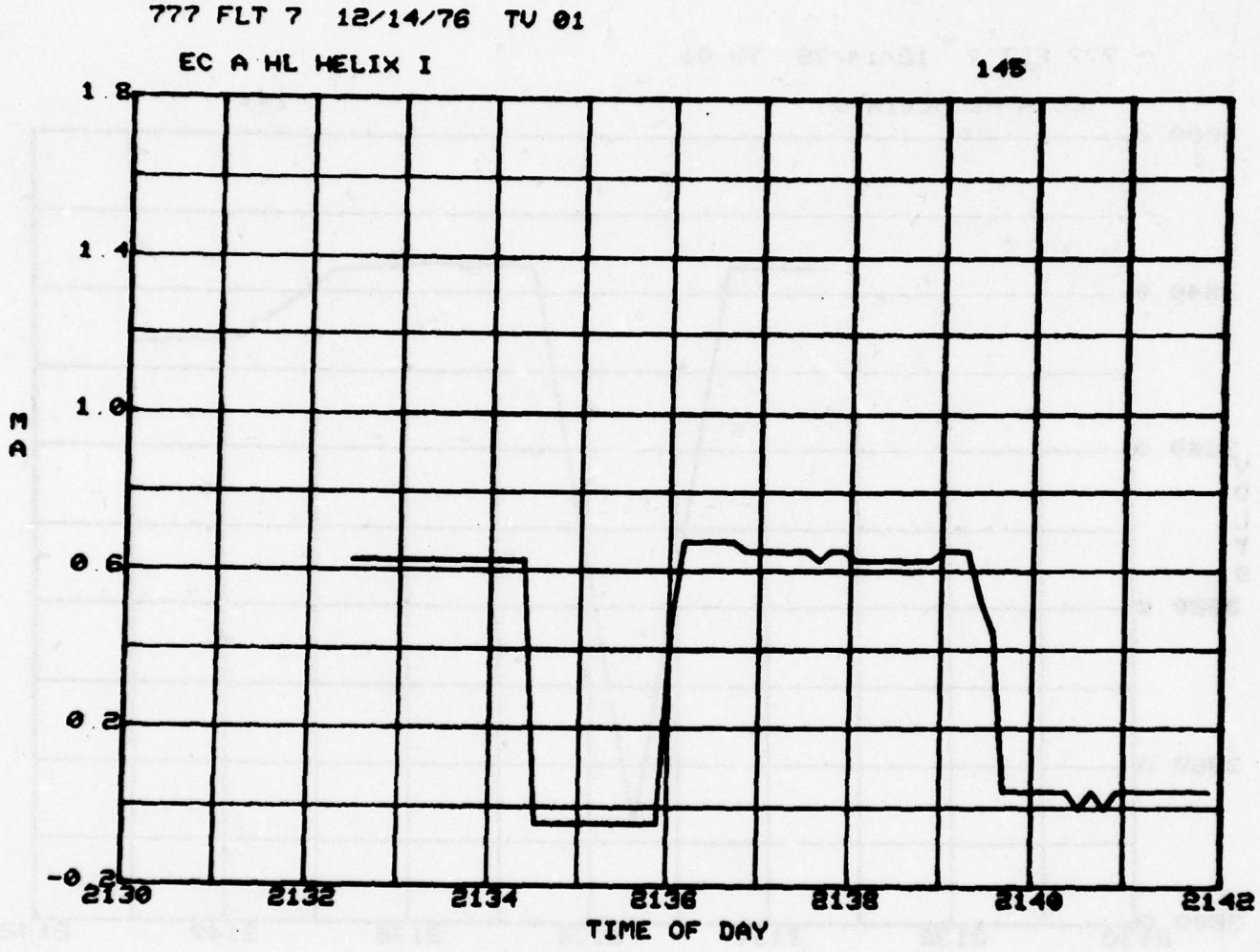
TIME OF DAY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1.8
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MA
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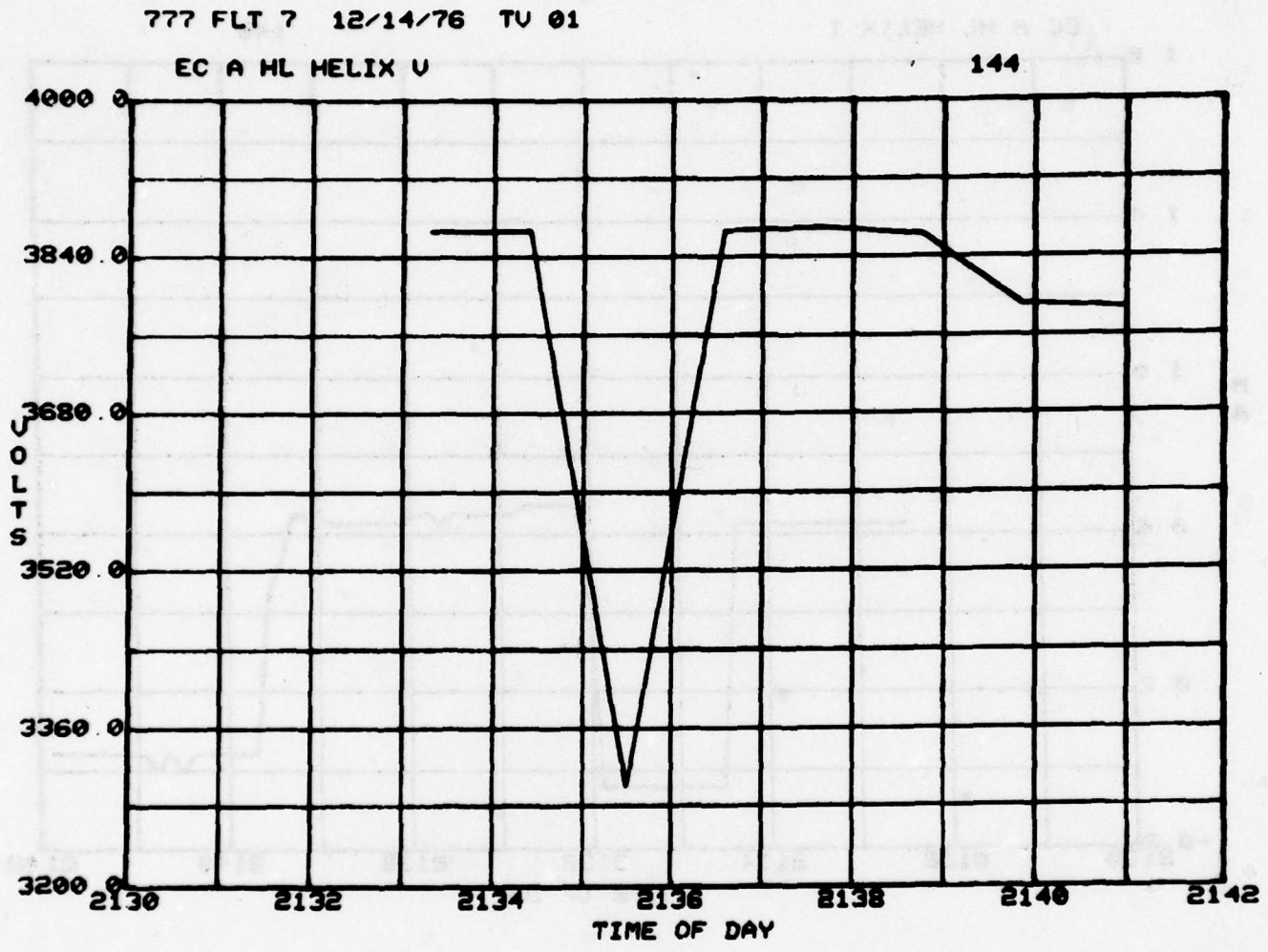
TIME OF DAY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VOLTS
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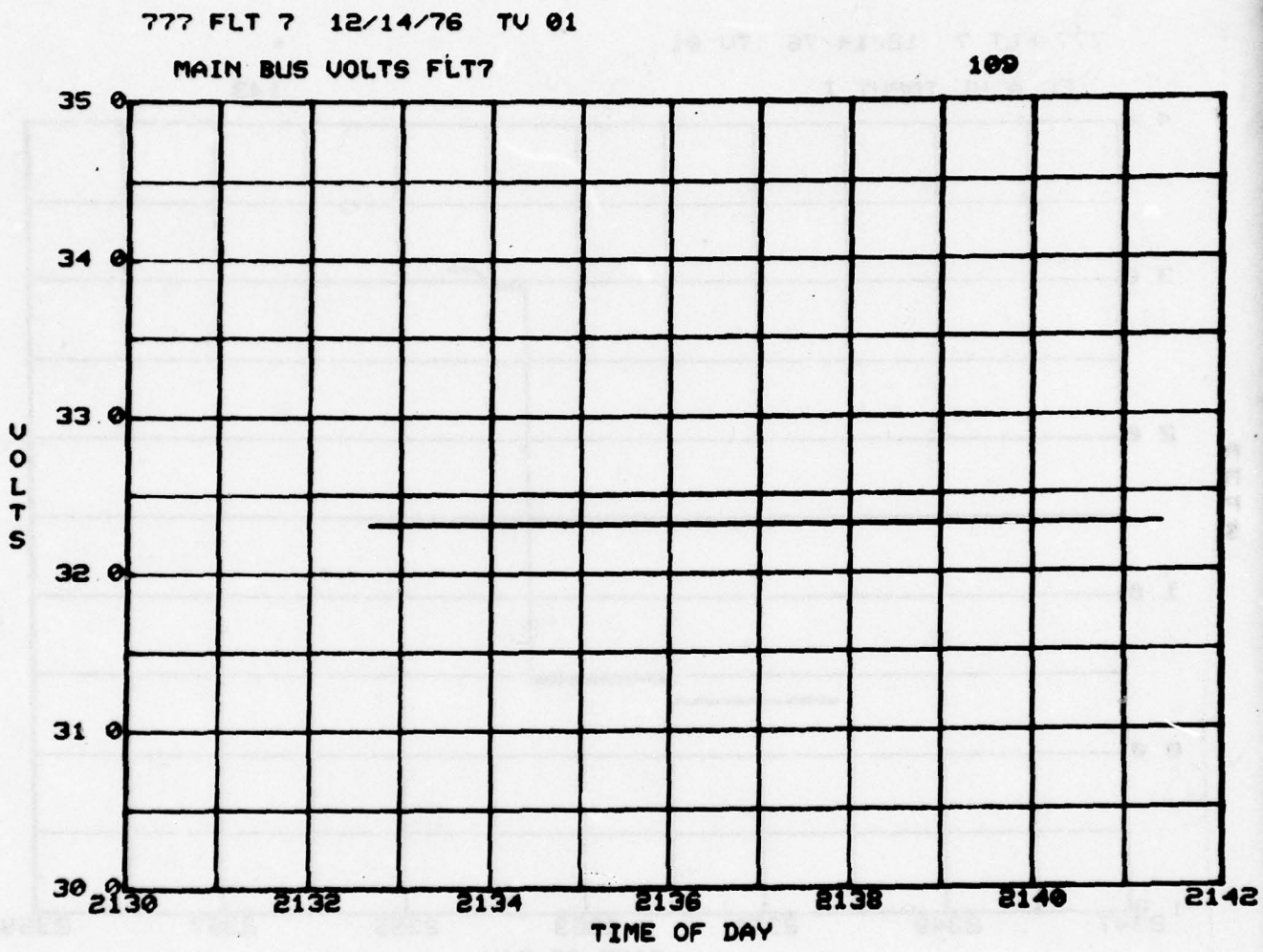
TIME OF DAY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MAIN BUS VOLTS FLT7
109
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31 0
30 0
VOLTS
2130
2132
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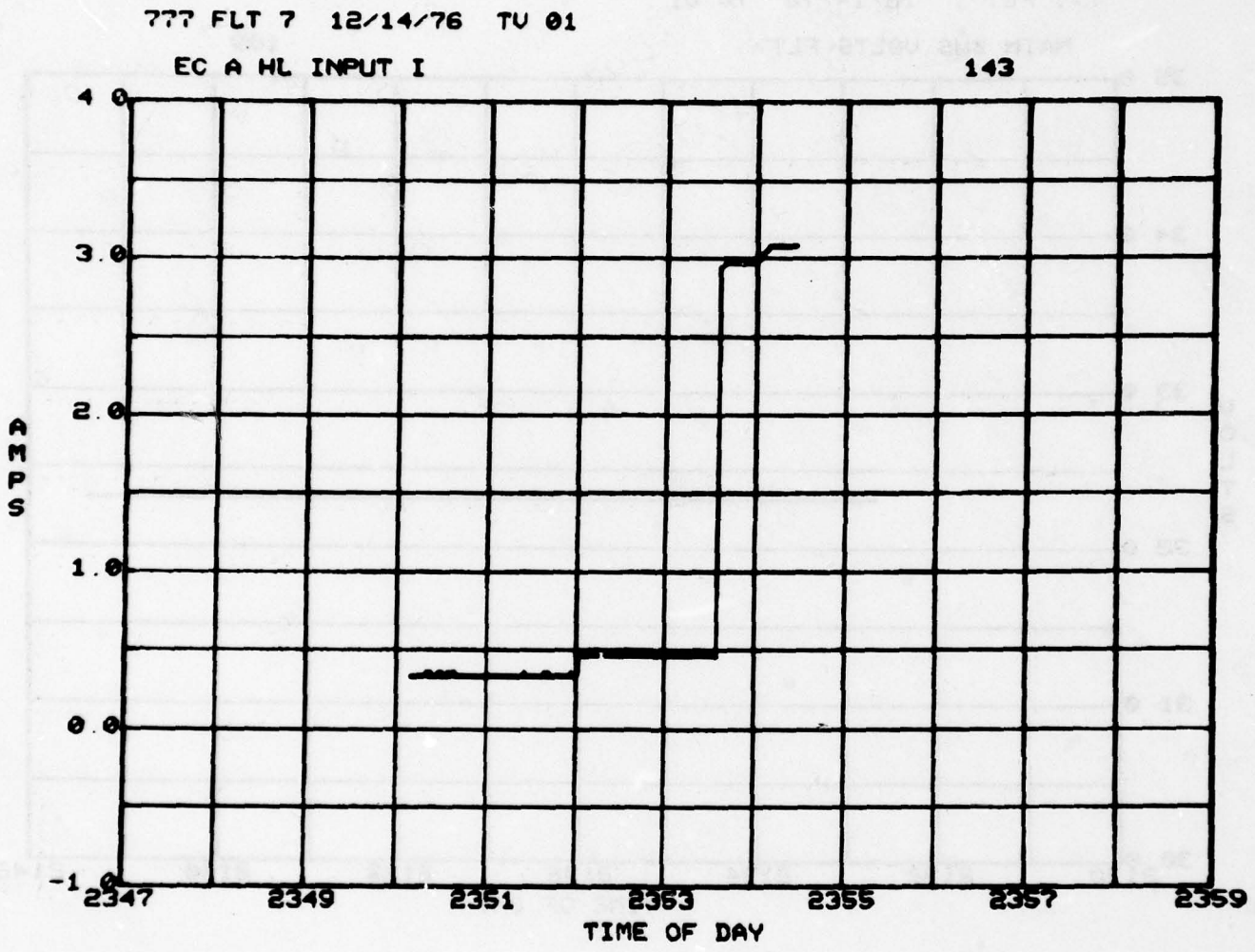
TIME OF DAY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EC A HL INPUT I
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4.0
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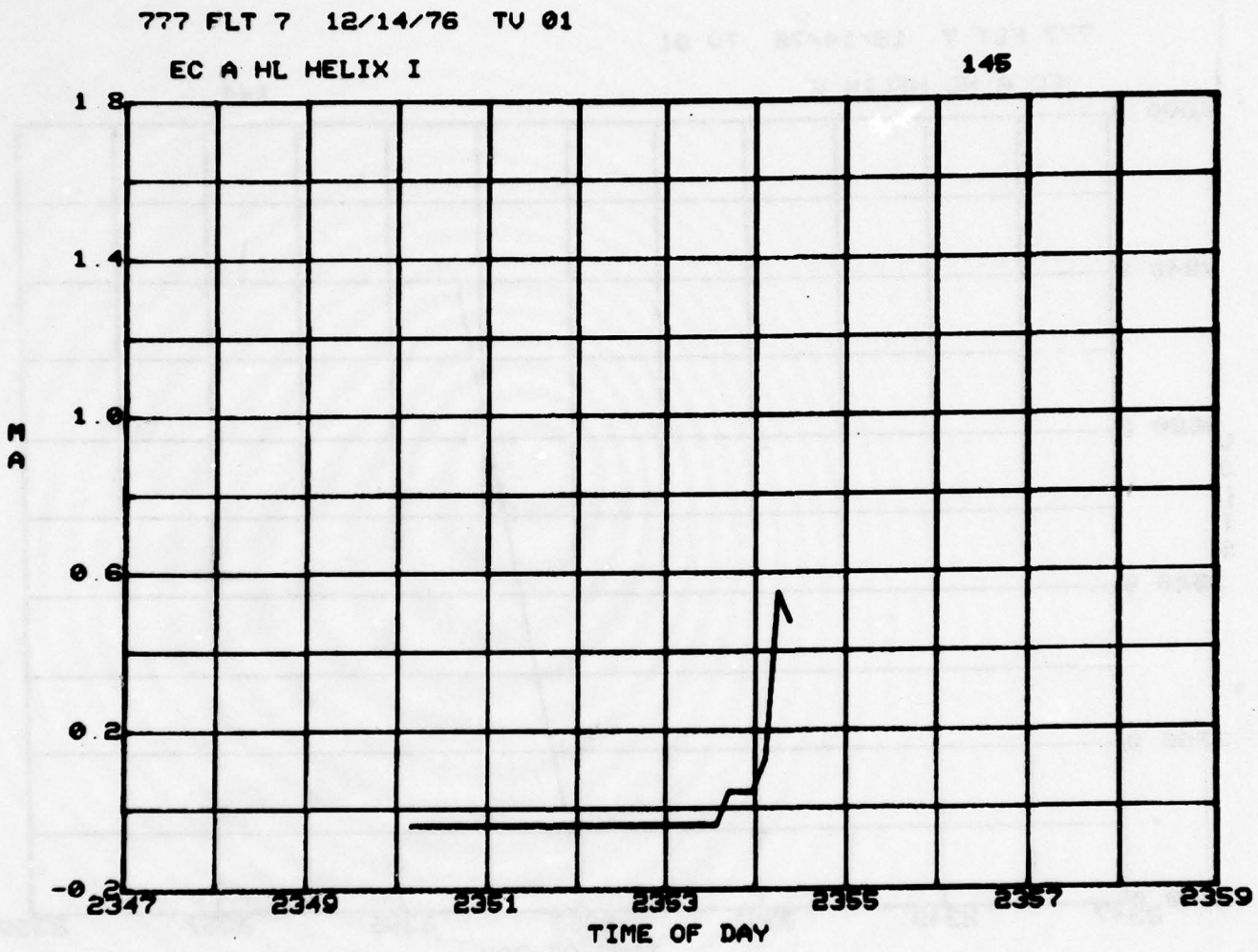
0.0
-1.0
AMPS
2347
2349
2351
2353
2355
2357
2359
TIME OF DAY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EC A HL HELIX I
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1.8
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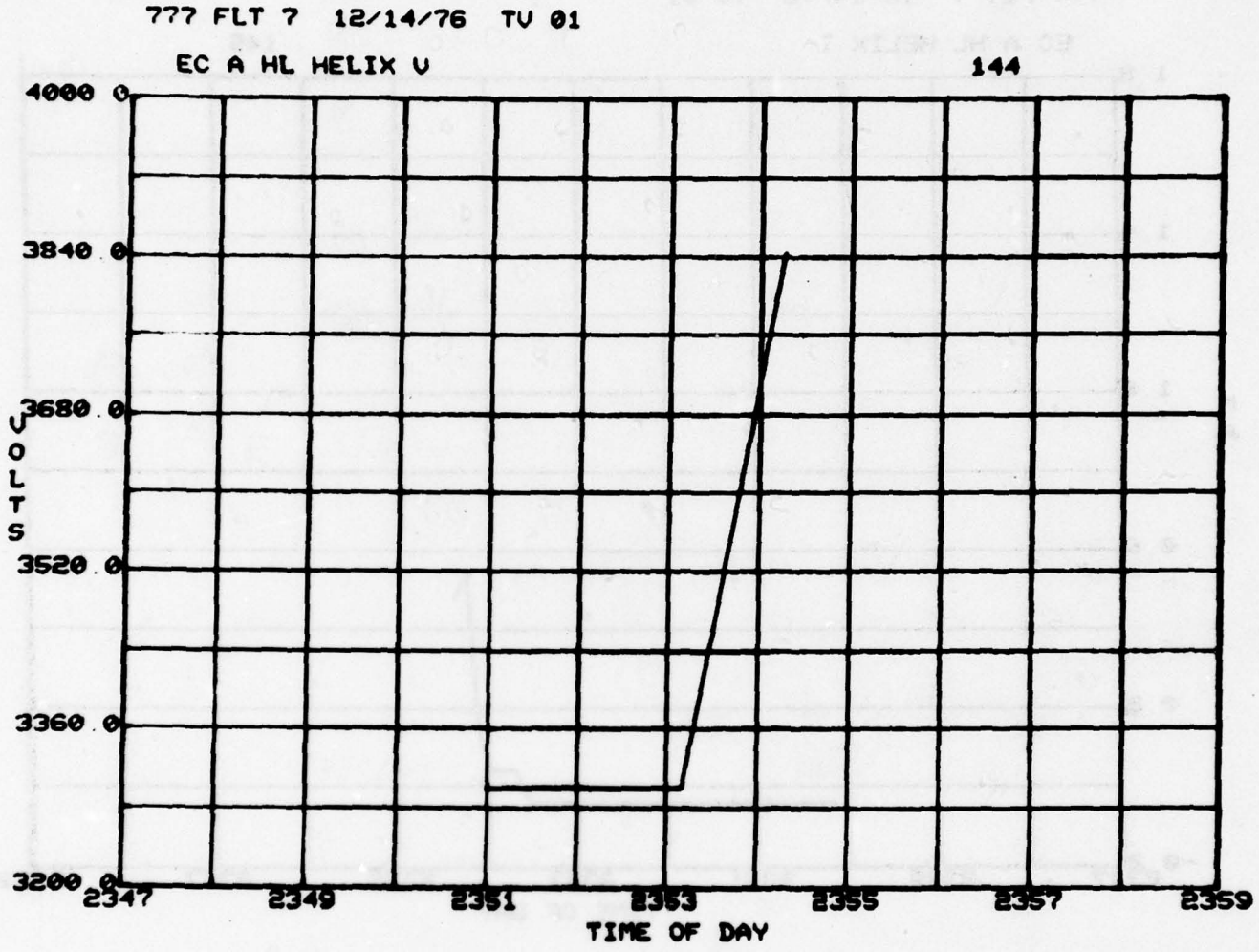
0.2
-0.2
MA
2347
2349
2351
2353
2355
2357
2359
TIME OF DAY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EC A HL HELIX V
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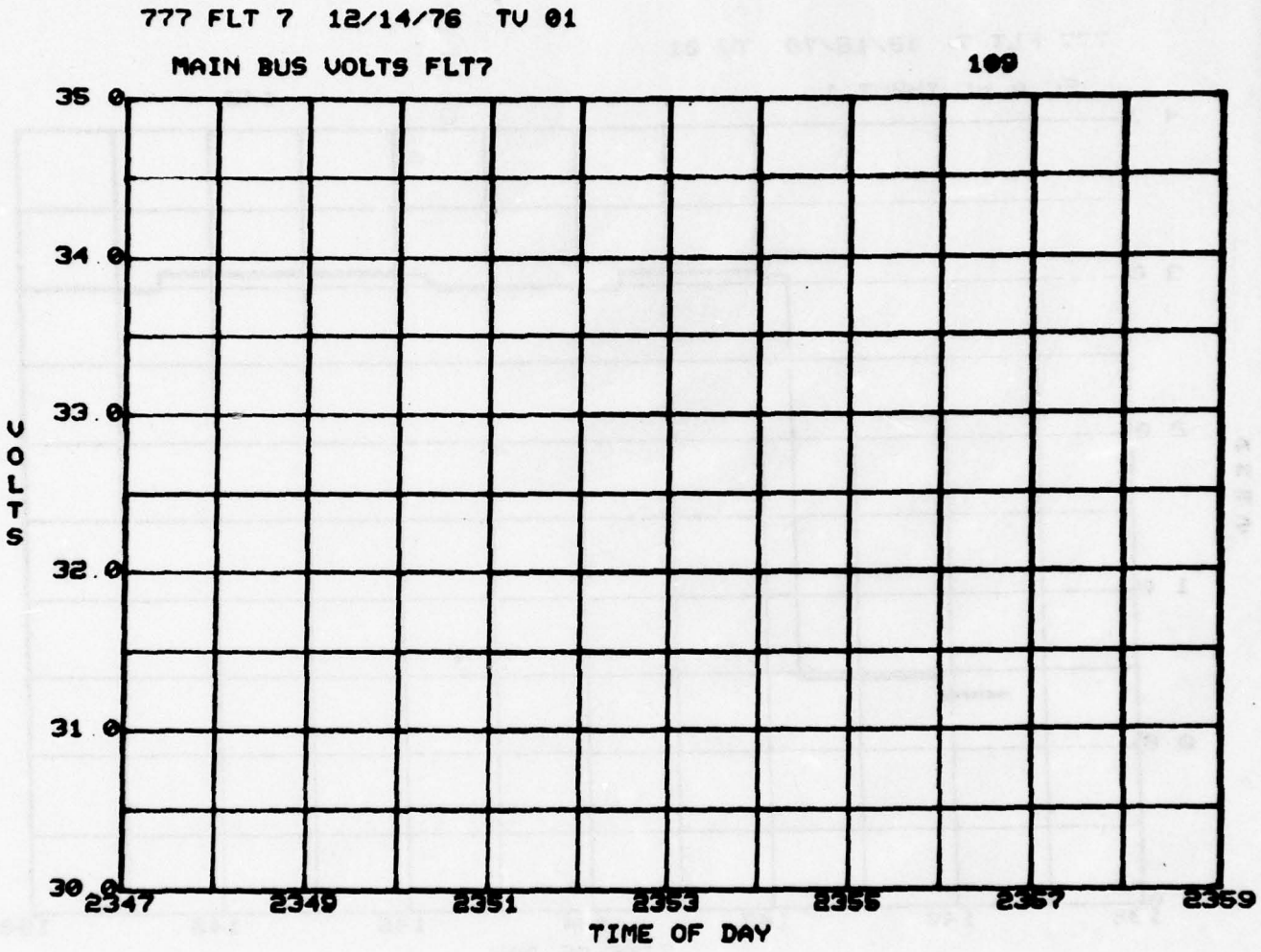
2359
TIME OF DAY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MAIN BUS VOLTS FLT7
100
35.0
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31.0
30.0
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2349
2351
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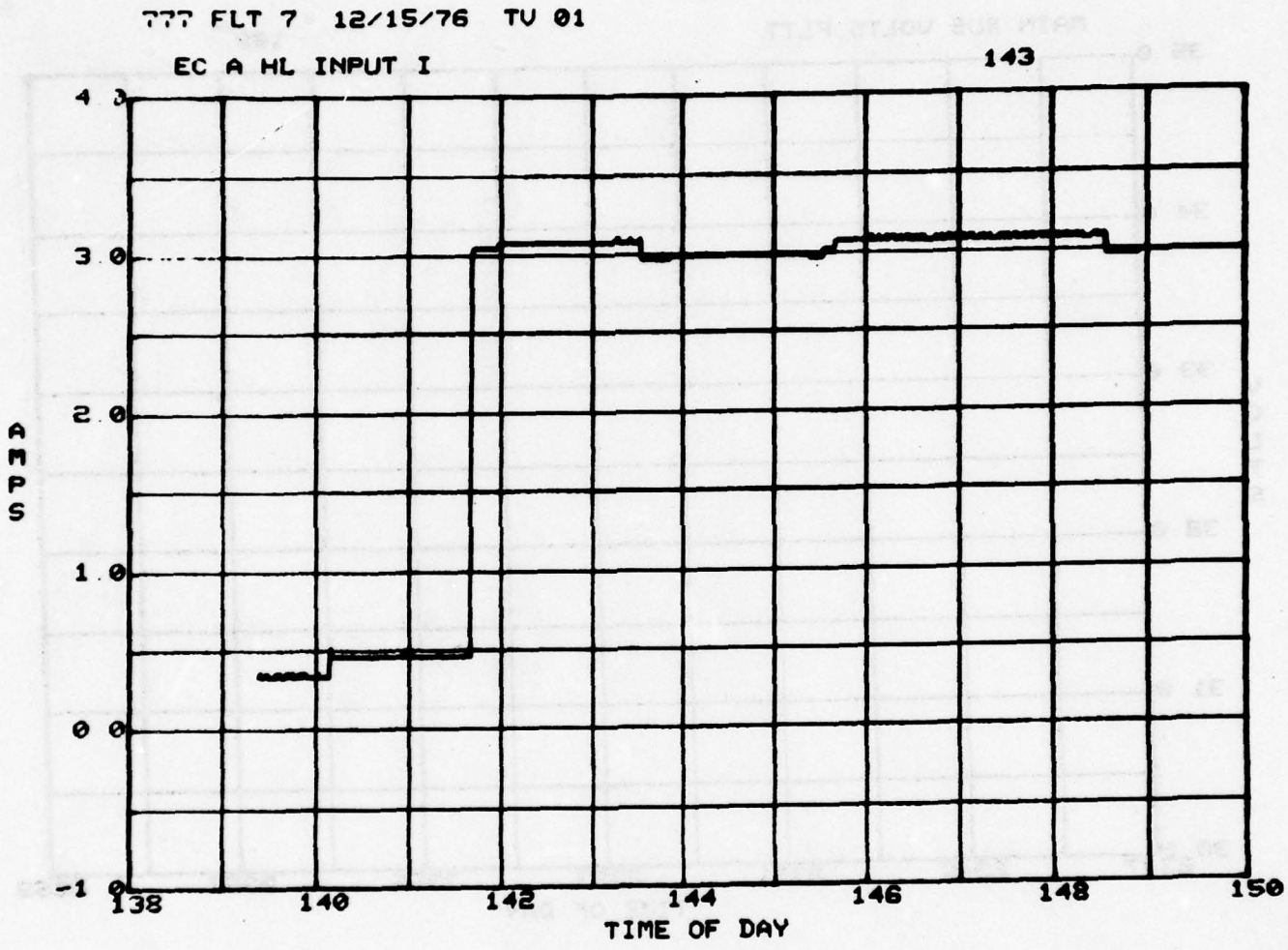
2355
2357
2359
TIME OF DAY


??? FLT 7 12/15/76 TV 01
EC A HL INPUT I
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-1.0
AMPS
138
140
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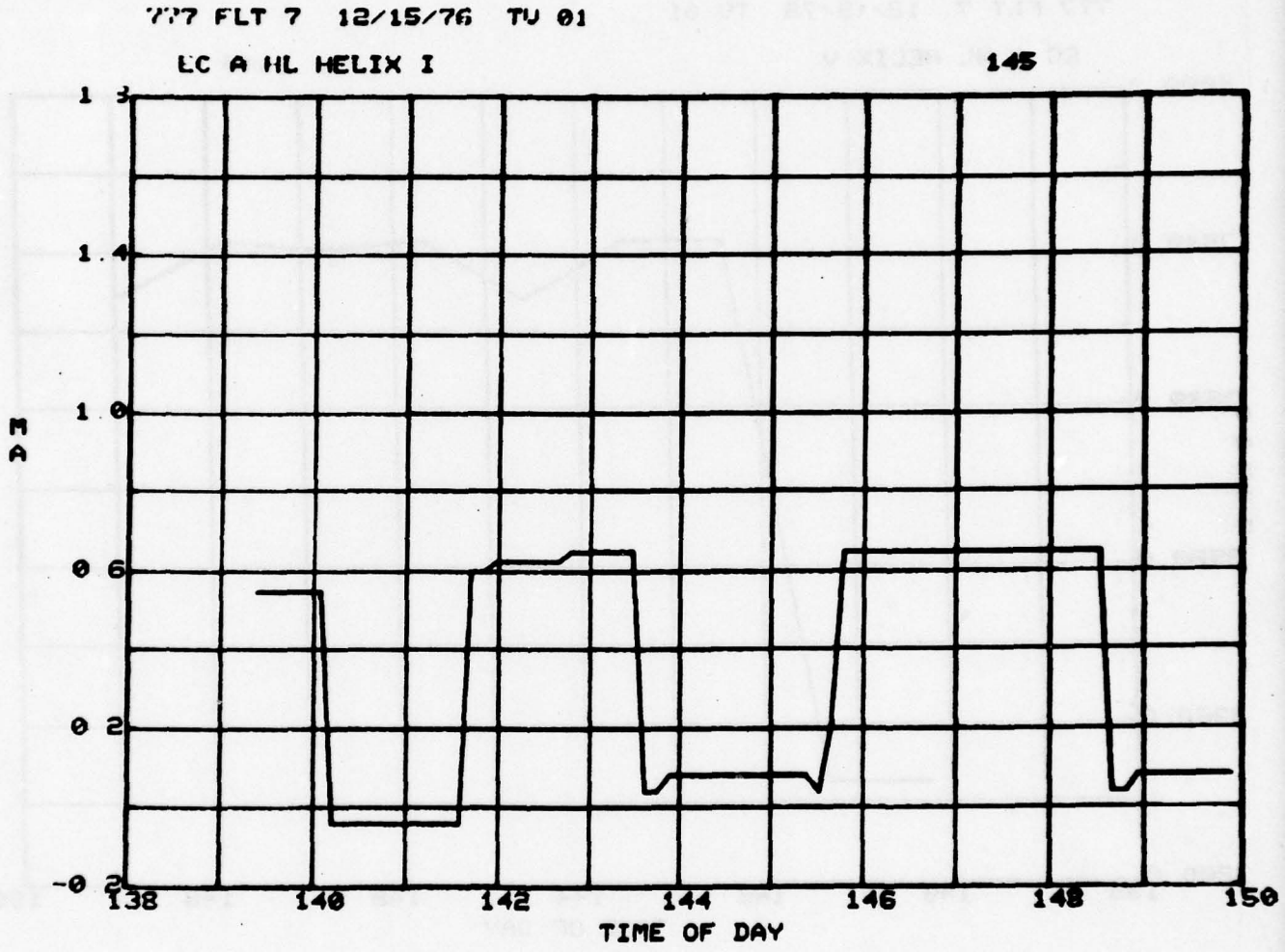
144
146
148
150
TIME OF DAY


777 FLT 7 12/15/76 TU 01
EC A HL HELIX I
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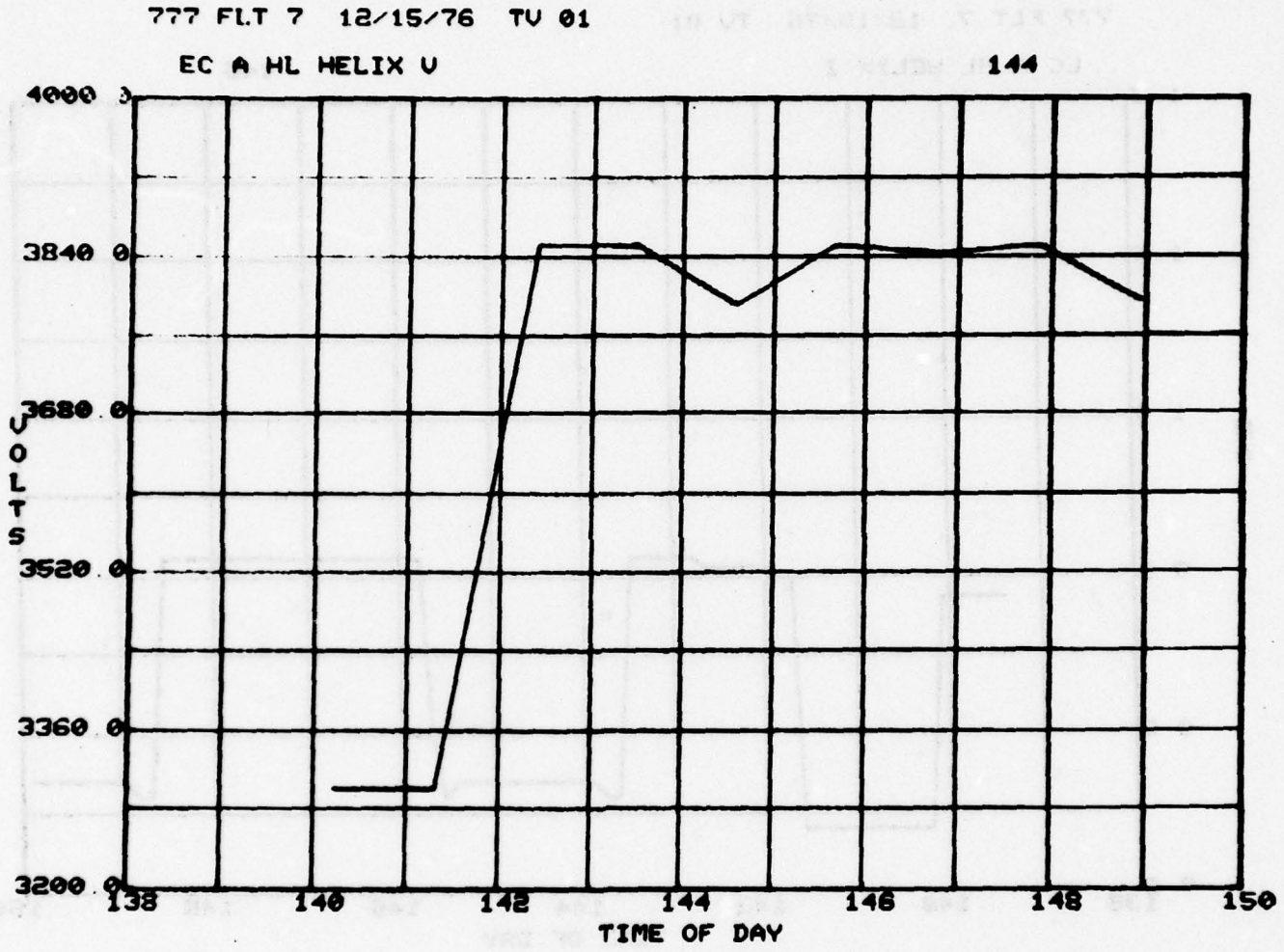
1 0
0 6
0 2
-0 2
MA
138
140
142
144
146
148
150
TIME OF DAY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EC A HL HELIX V
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3520 0
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3200 0
VOLTS
138
140
142
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146
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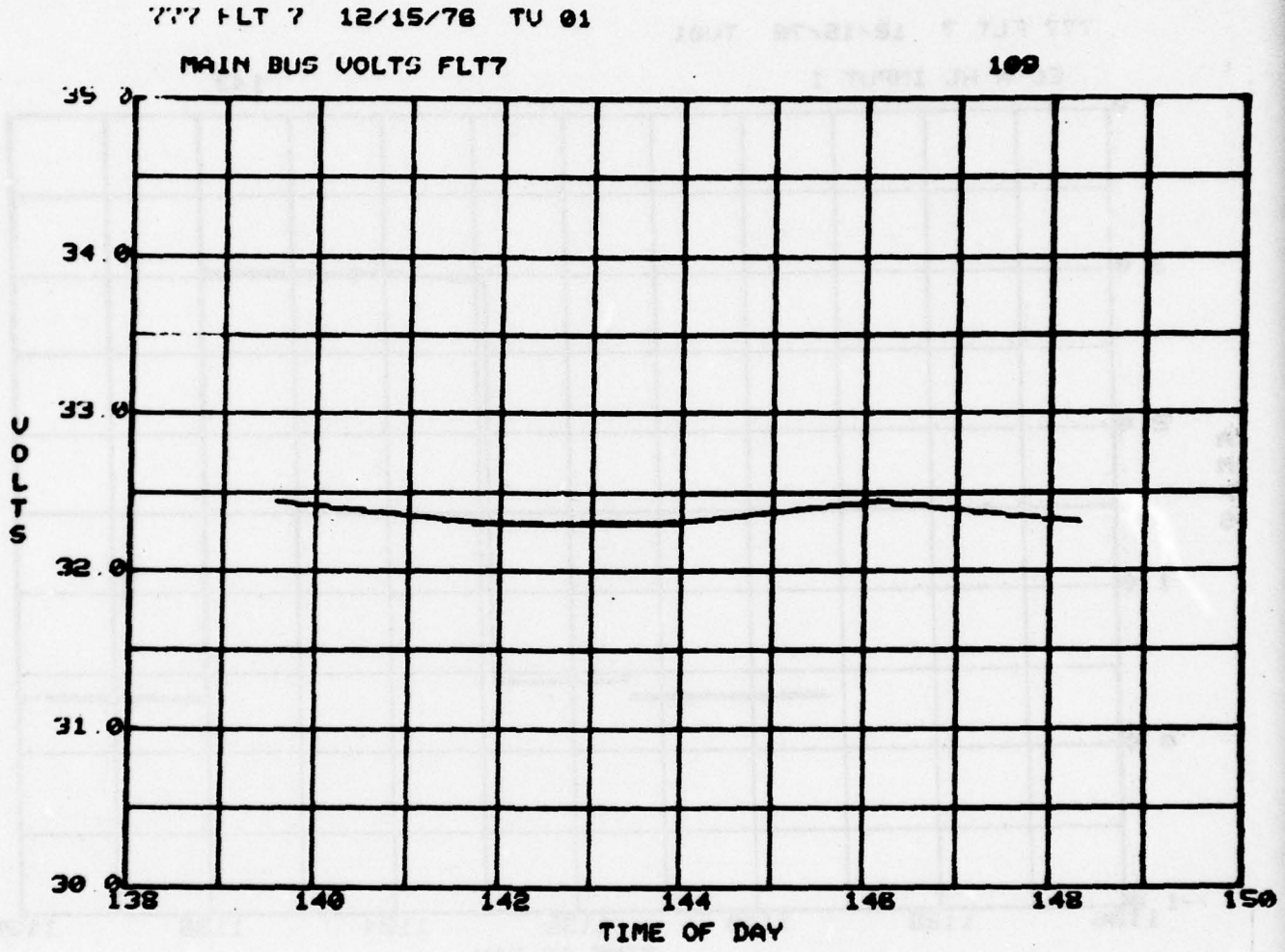
150
TIME OF DAY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VOLTS
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140
142
144
146
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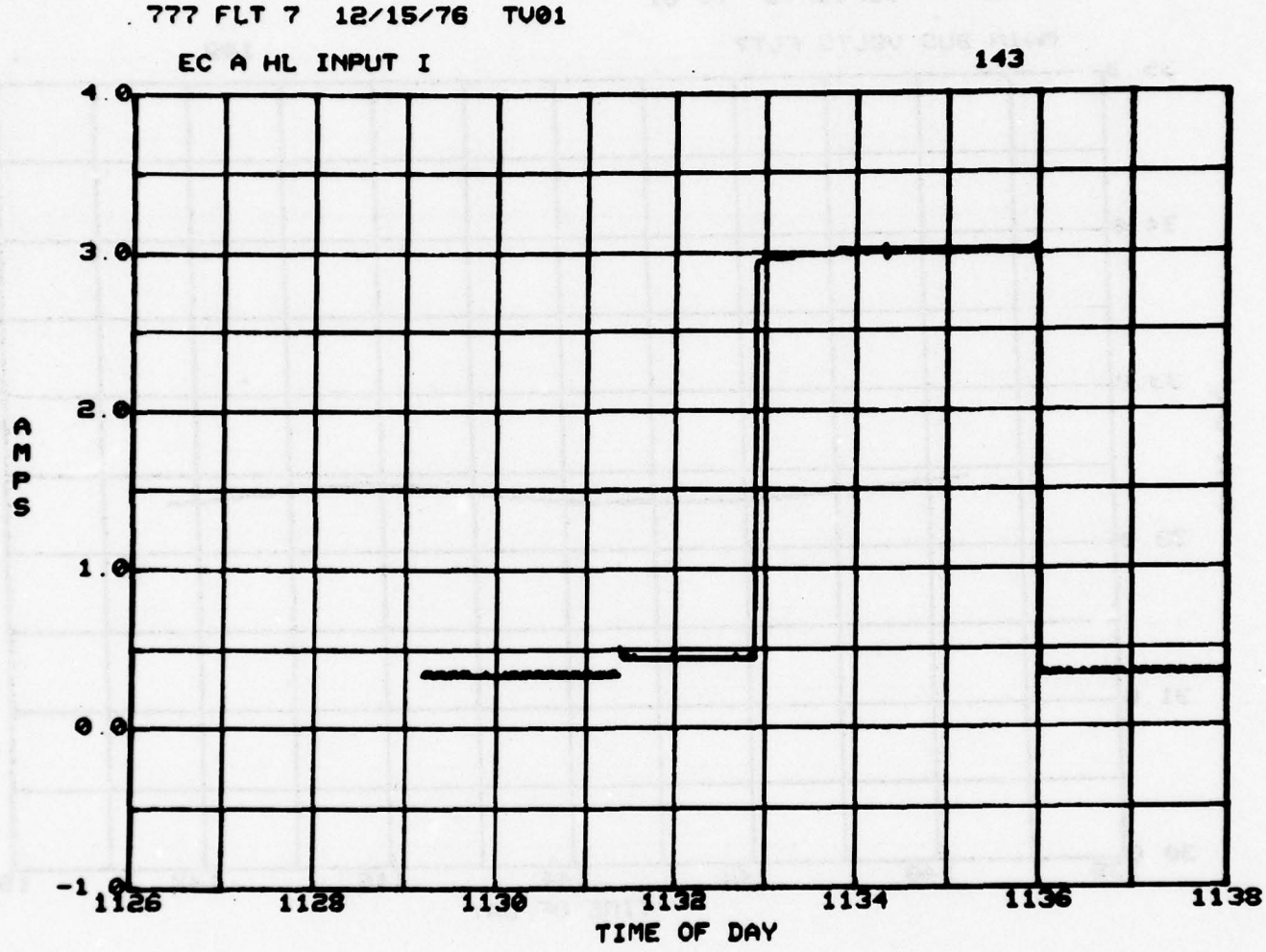
150
TIME OF DAY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AMPS
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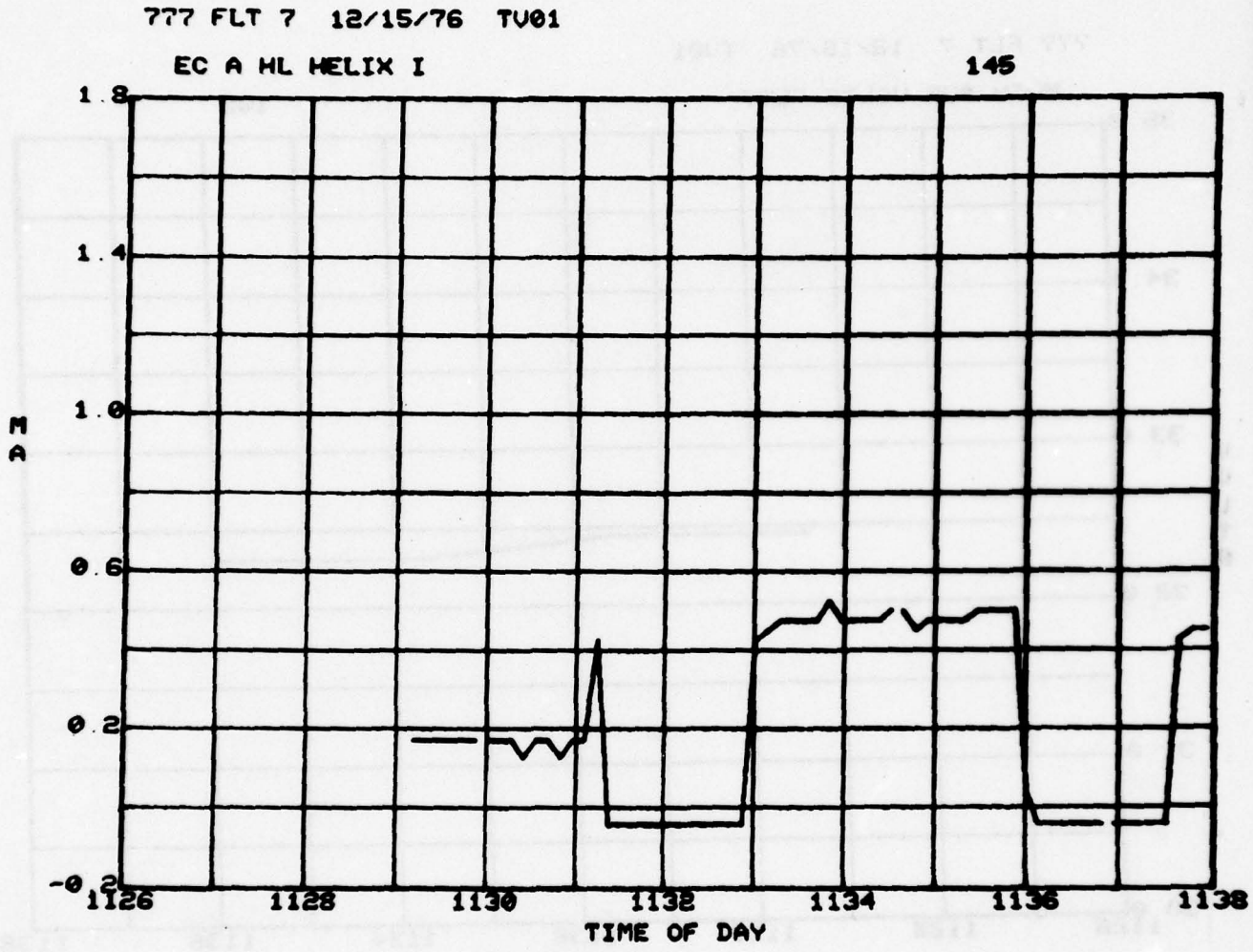
1138
TIME OF DAY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EC A HL HELIX I
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1.8
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MA
1126
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1134
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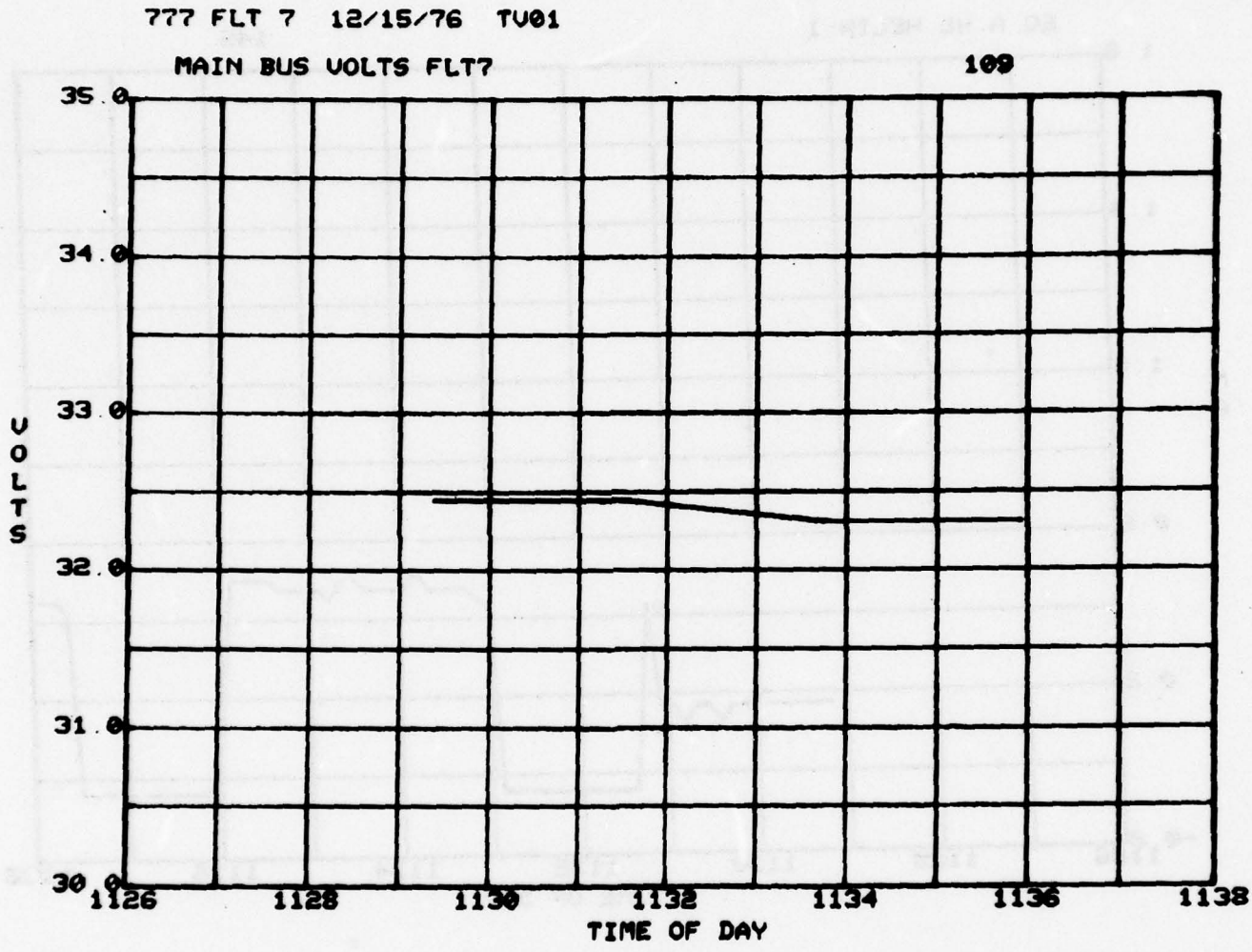
TIME OF DAY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MAIN BUS VOLTS FLT7
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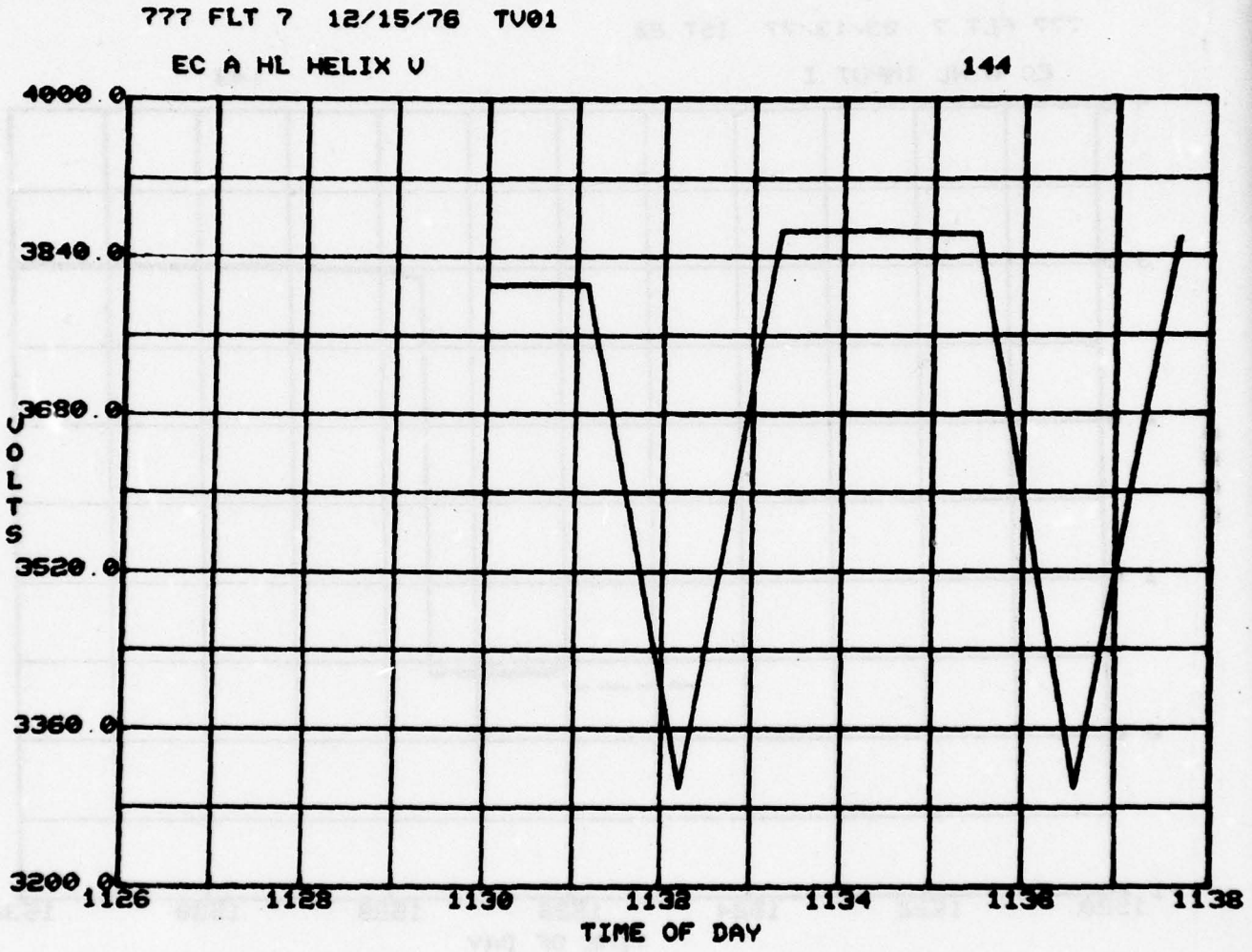
TIME OF DAY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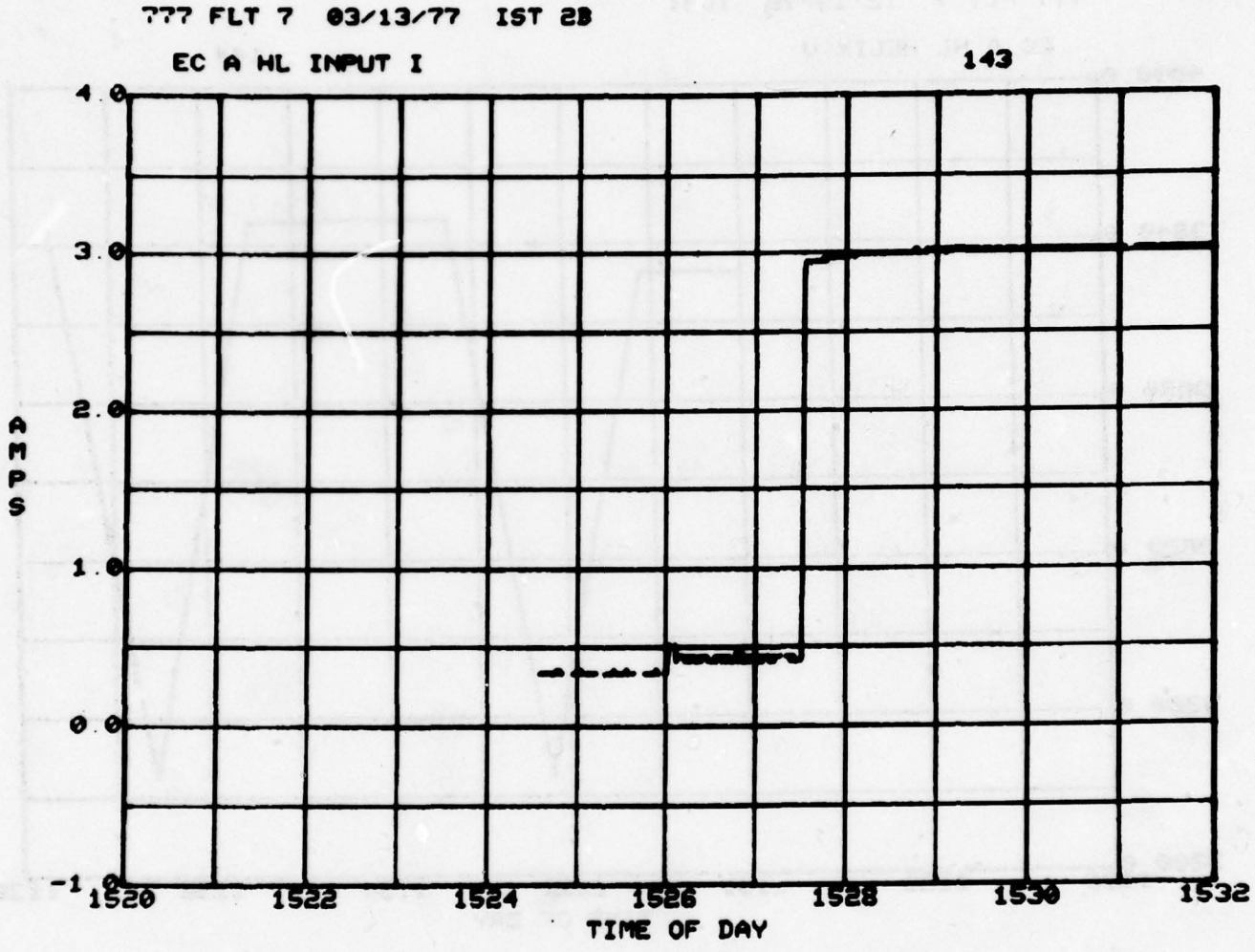
TIME OF DAY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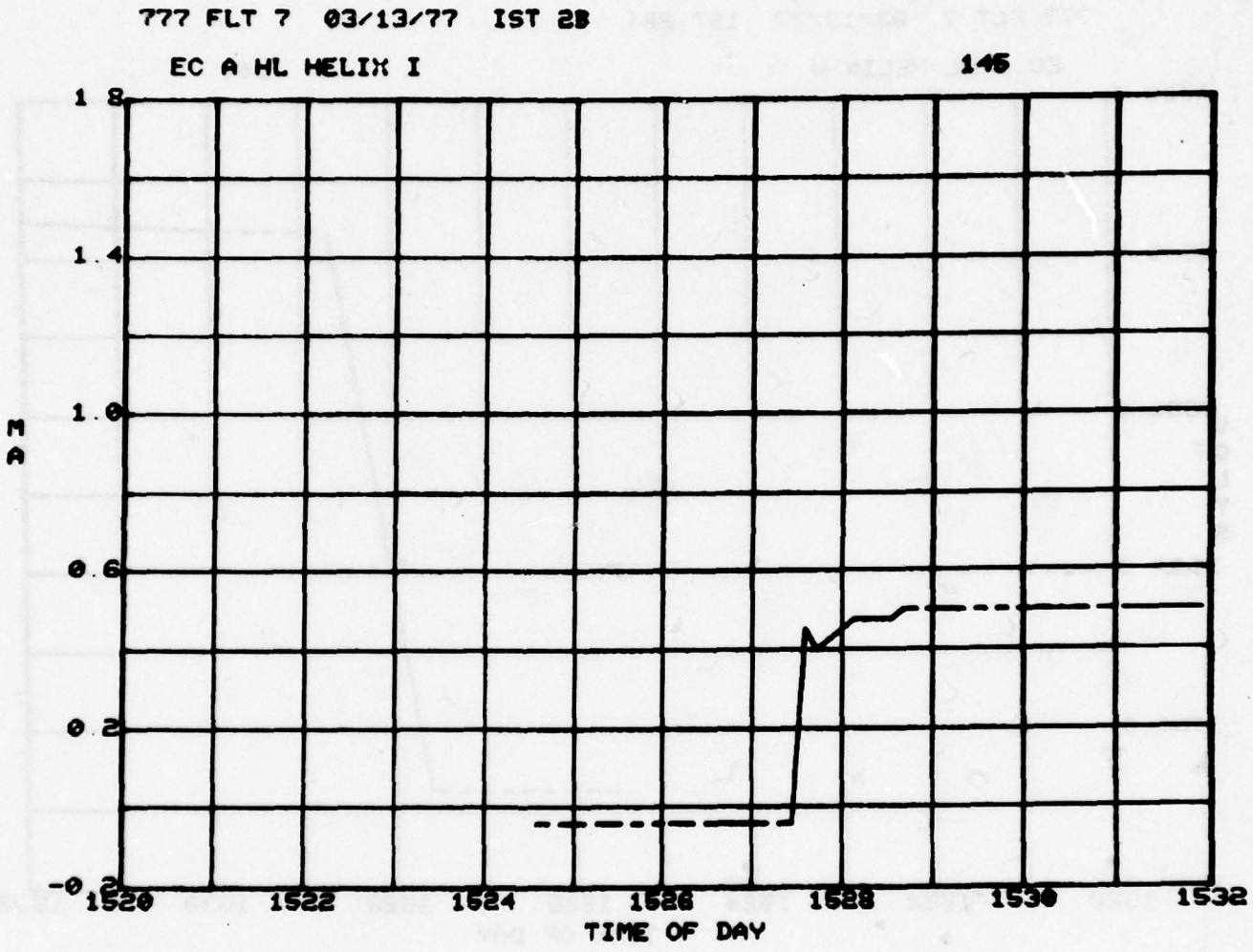
TIME OF DAY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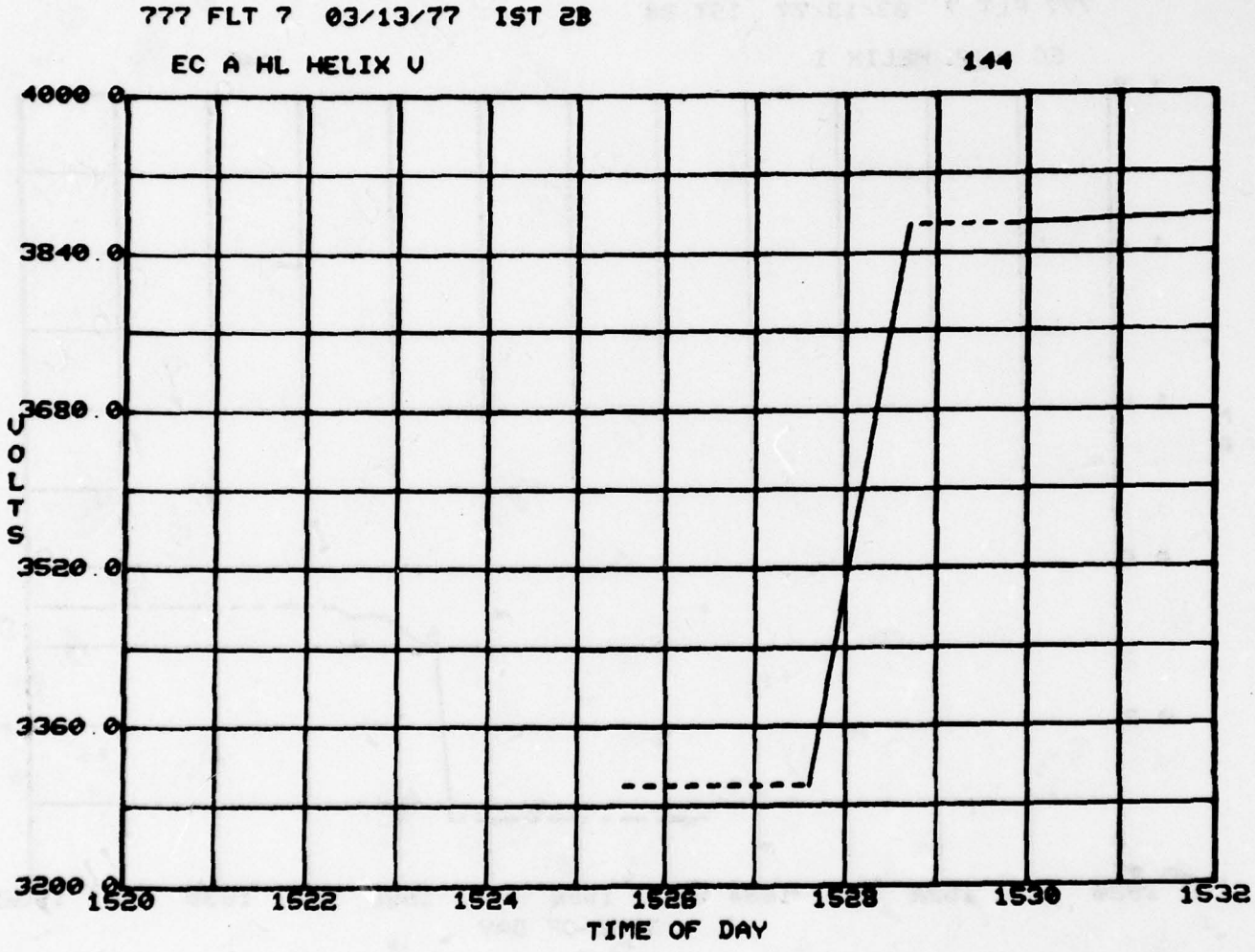
TIME OF DAY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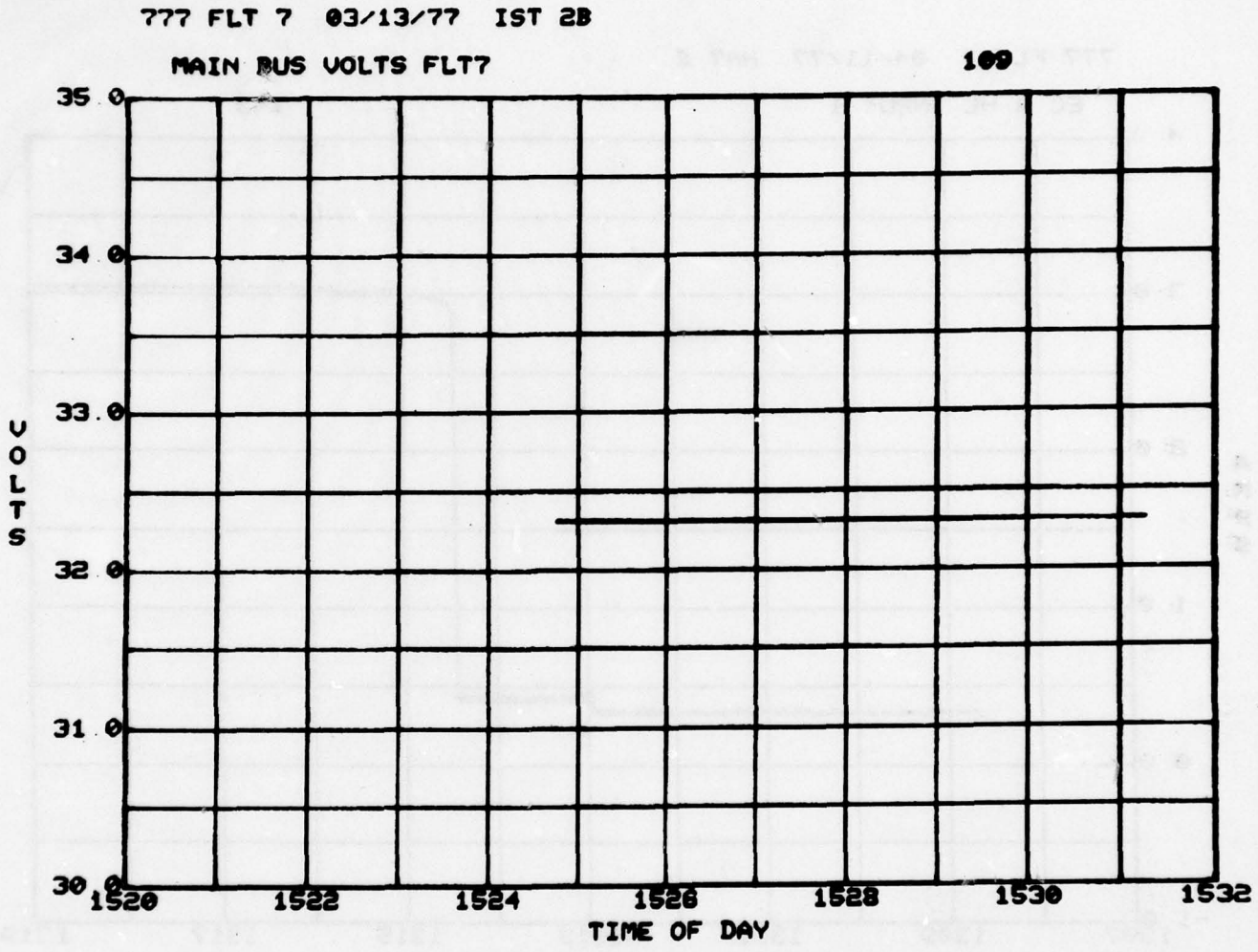
TIME OF DAY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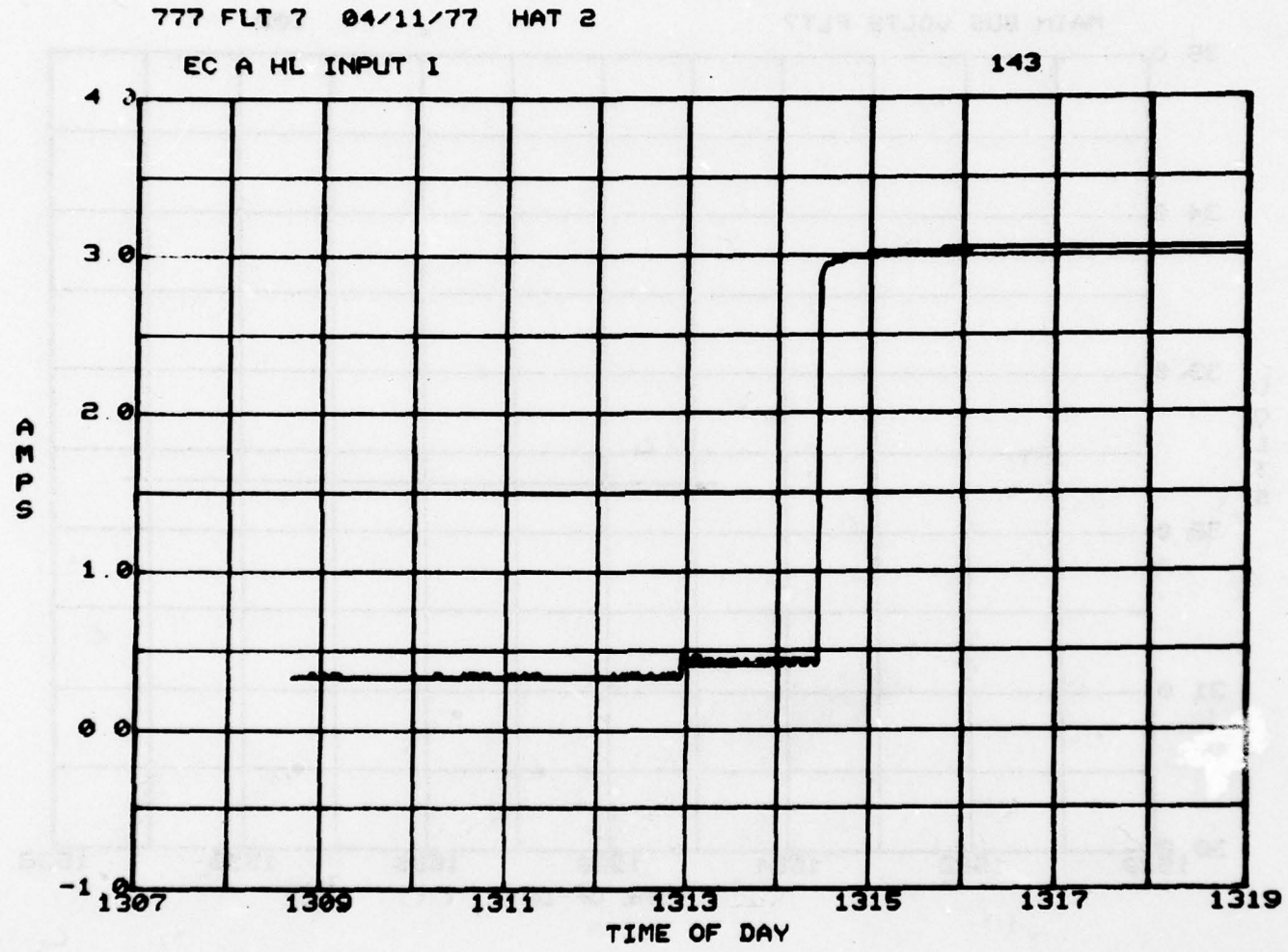
TIME OF DAY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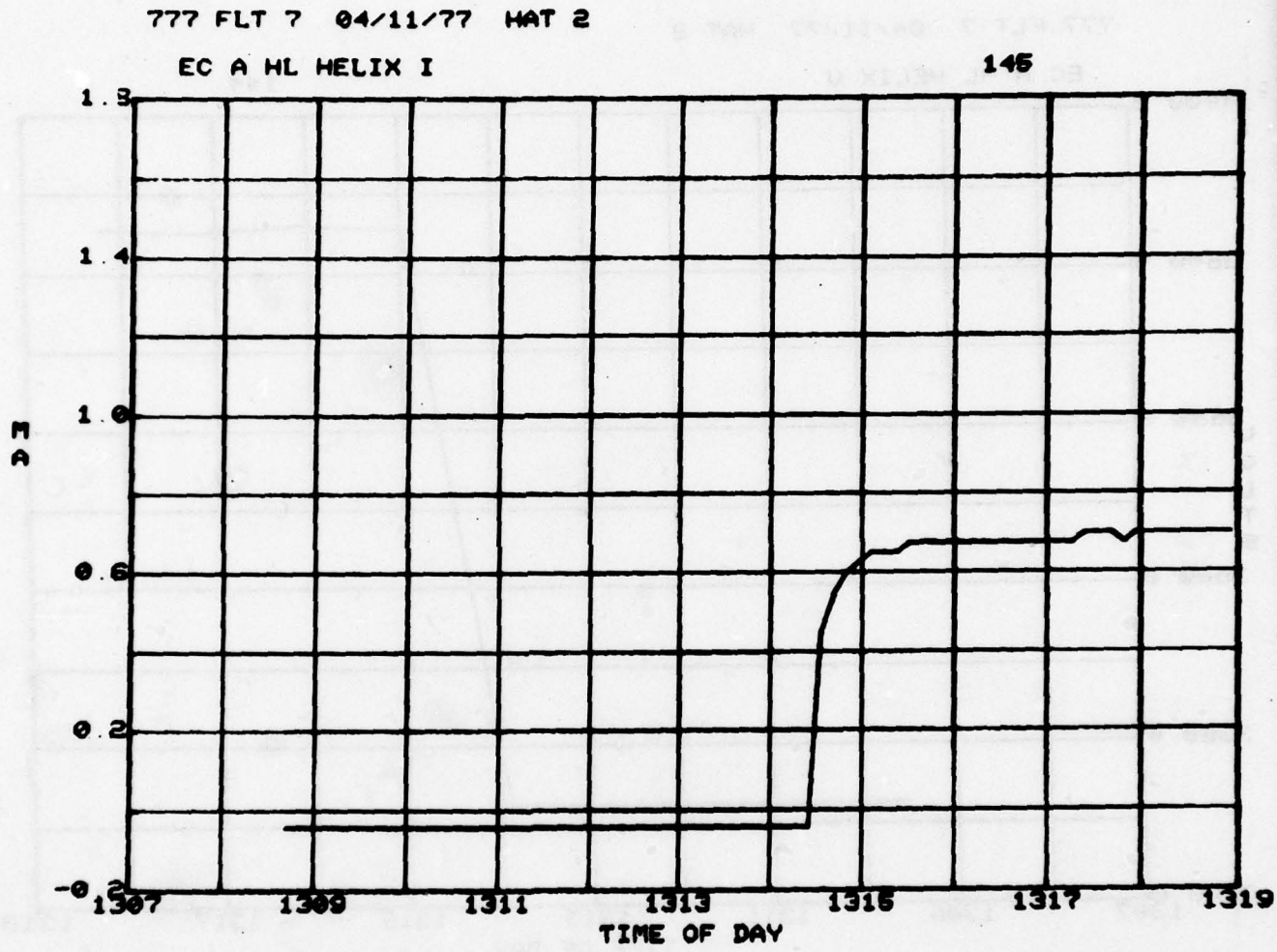
TIME OF DAY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MA
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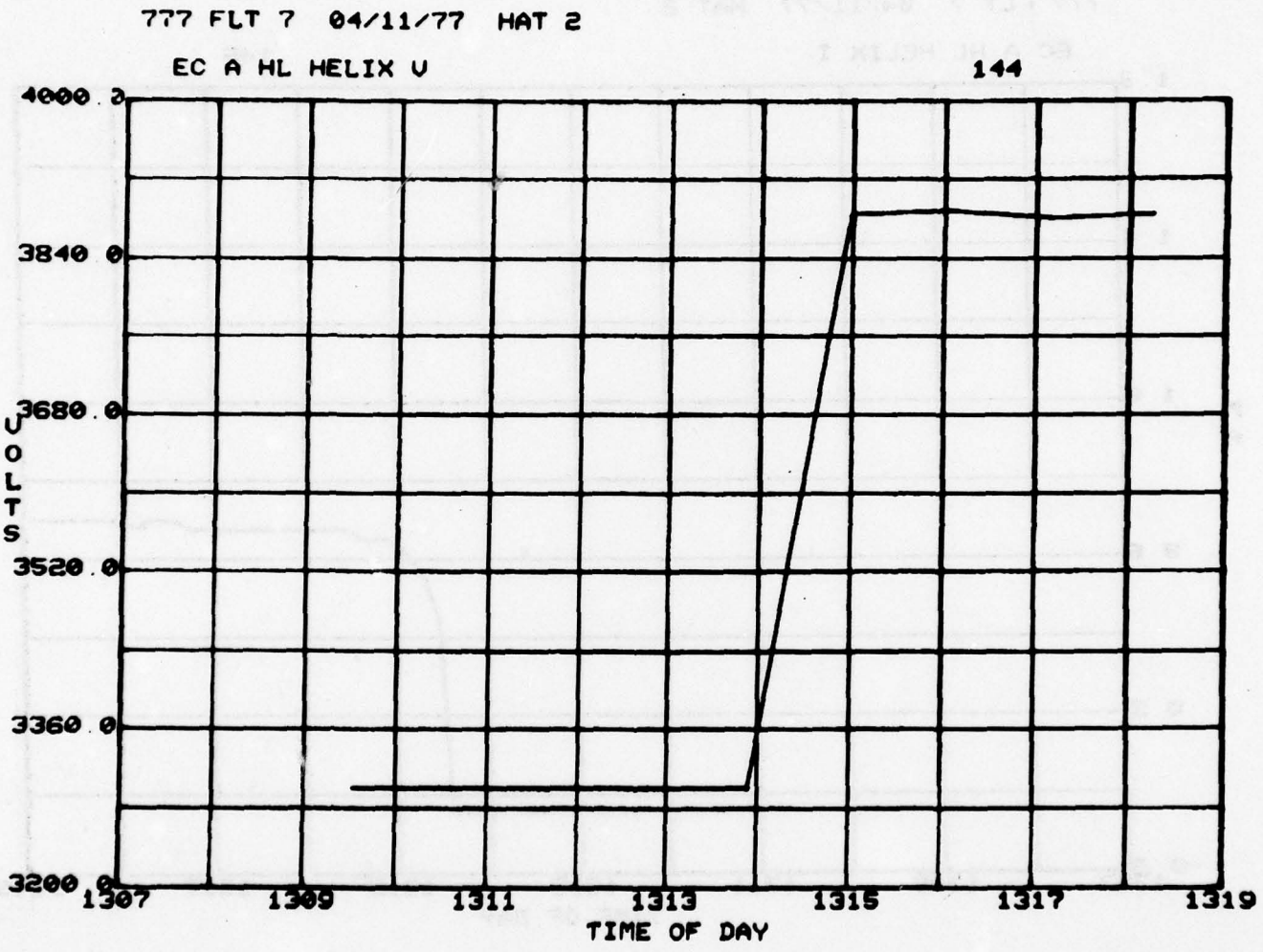
TIME OF DAY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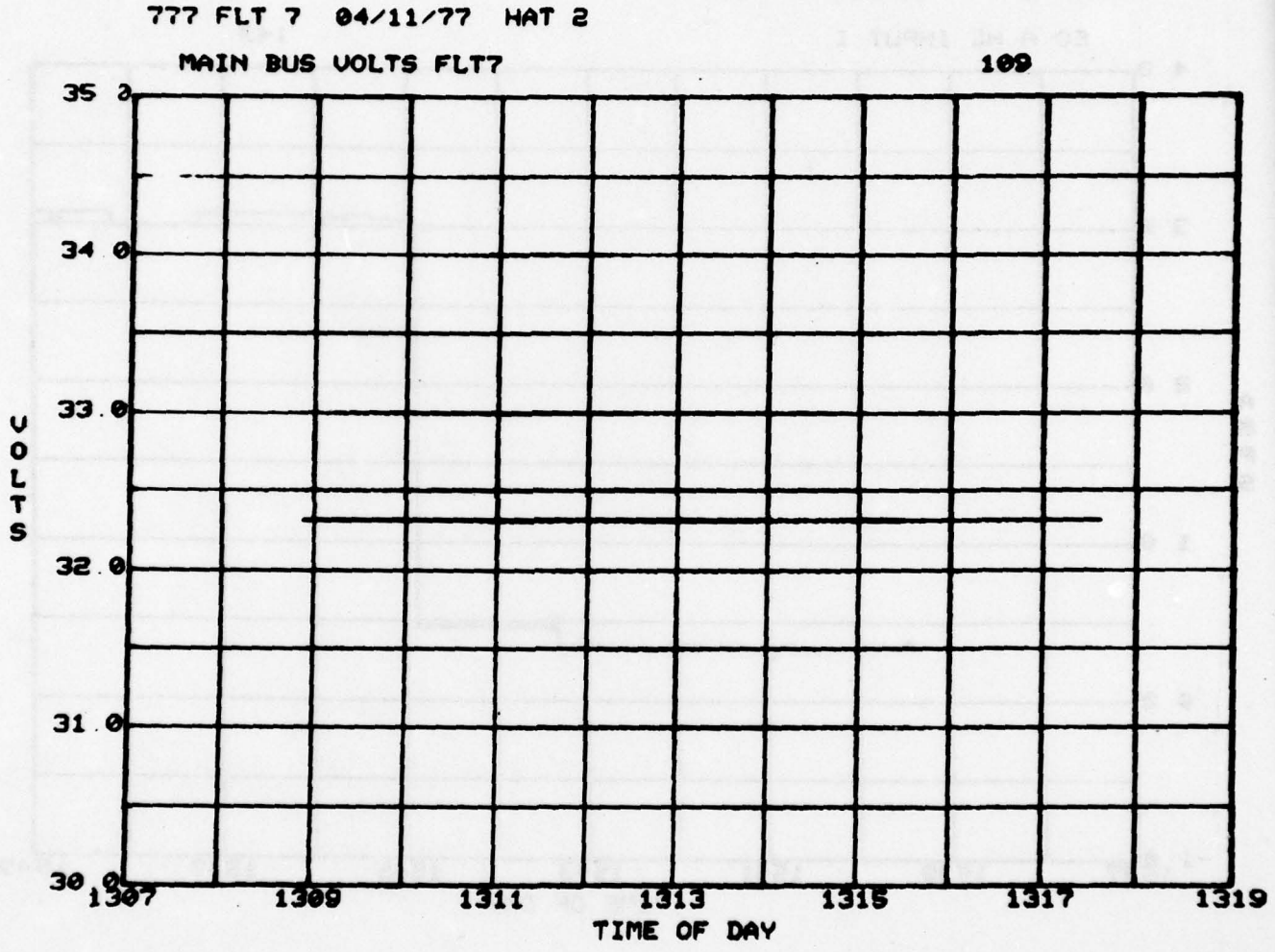
TIME OF DAY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MAIN BUS VOLTS FLT7
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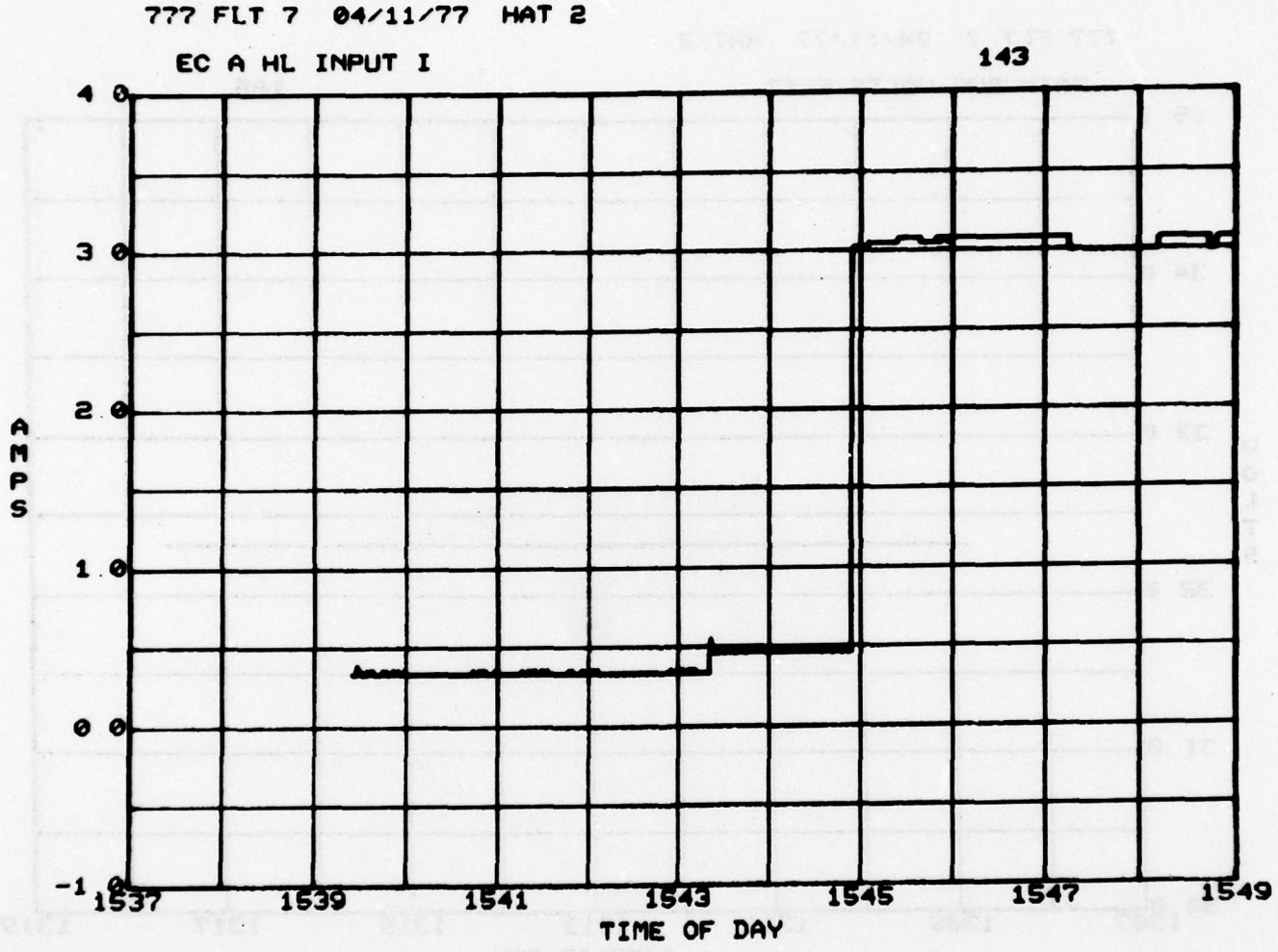
TIME OF DAY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EC A HL INPUT I
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AMPS
1537
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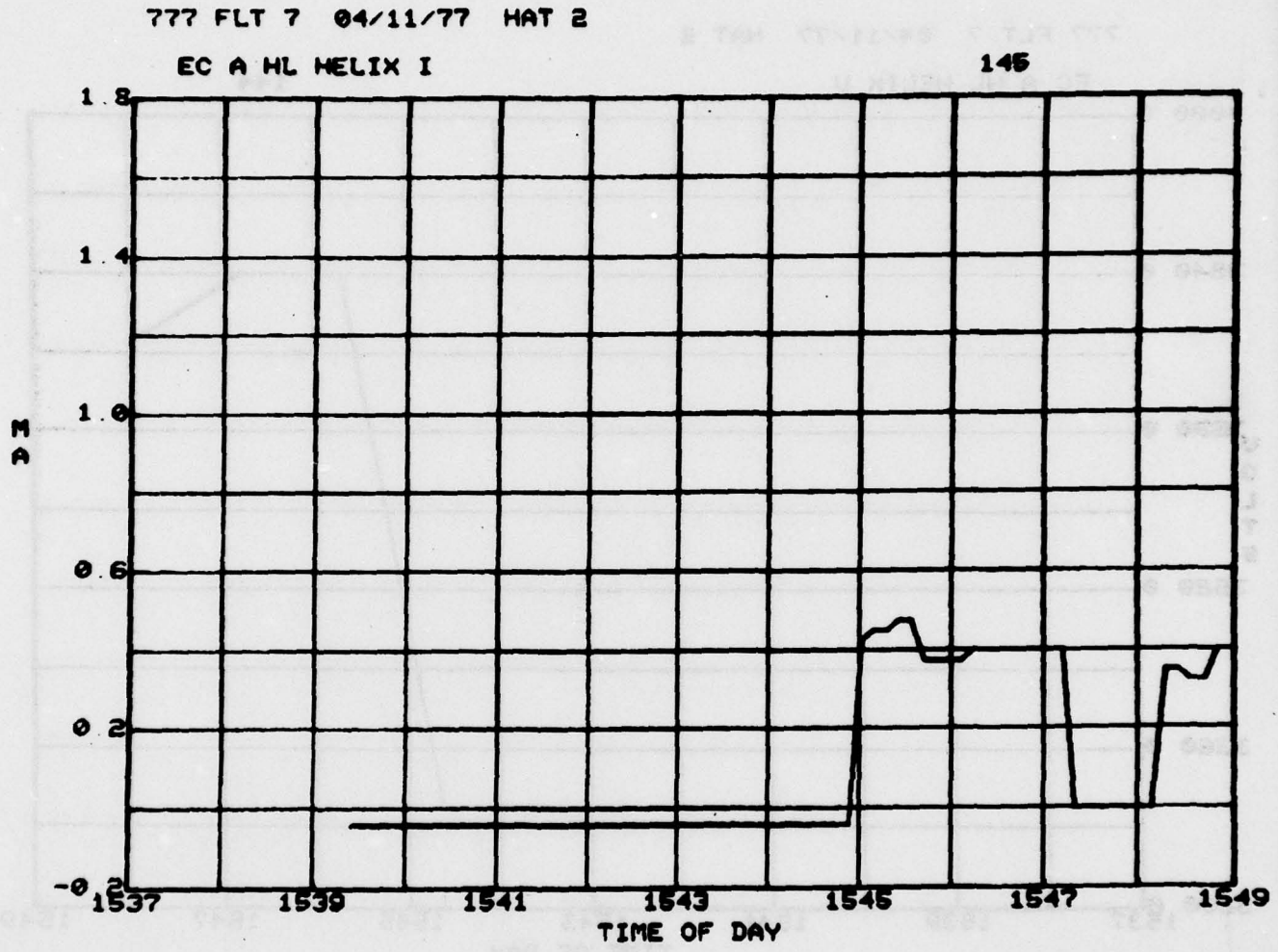
1541
1543
1545
1547
1549
TIME OF DAY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EC A HL HELIX I
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MA
1537
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1541
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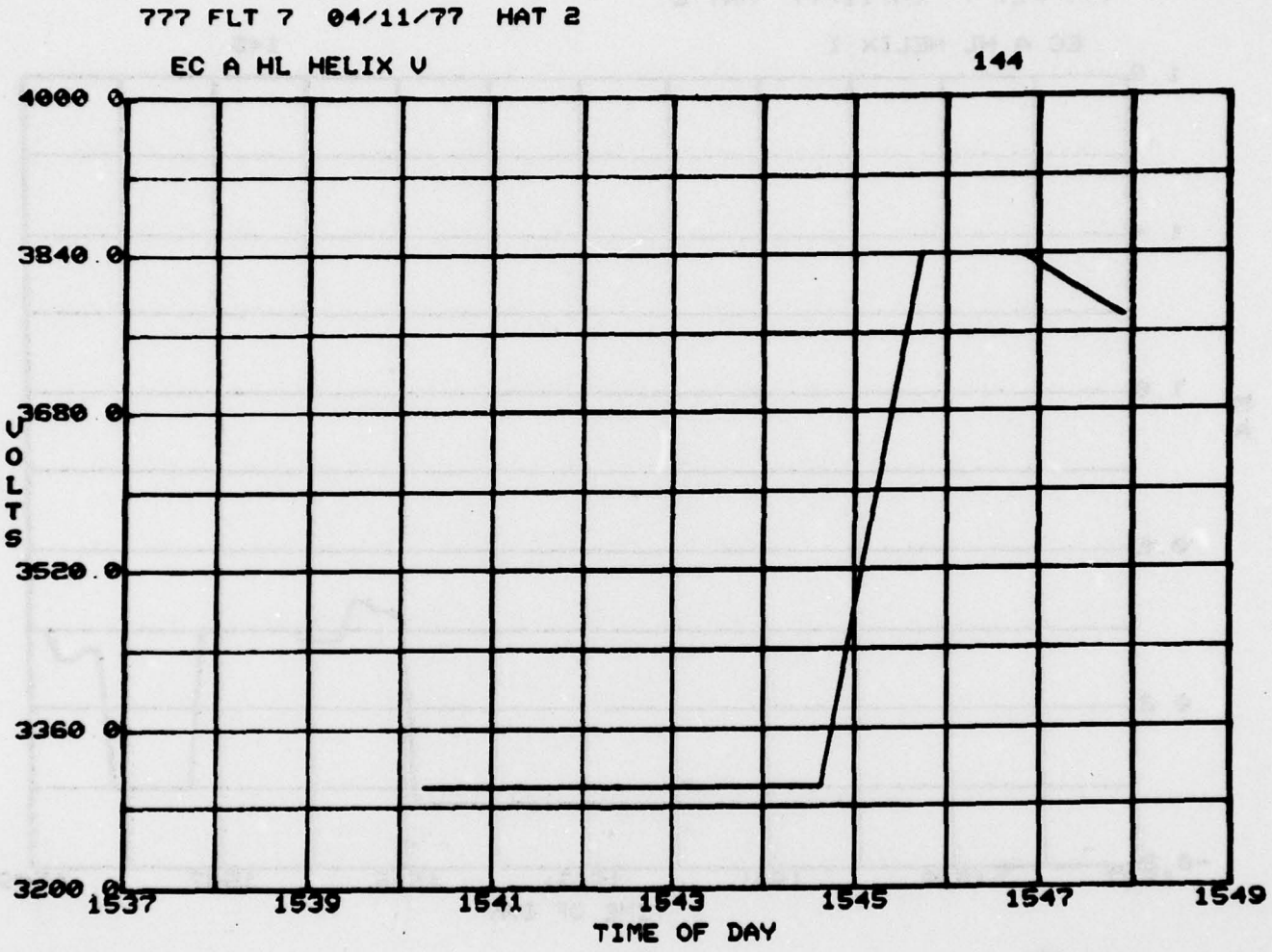
1545
1547
1549
TIME OF DAY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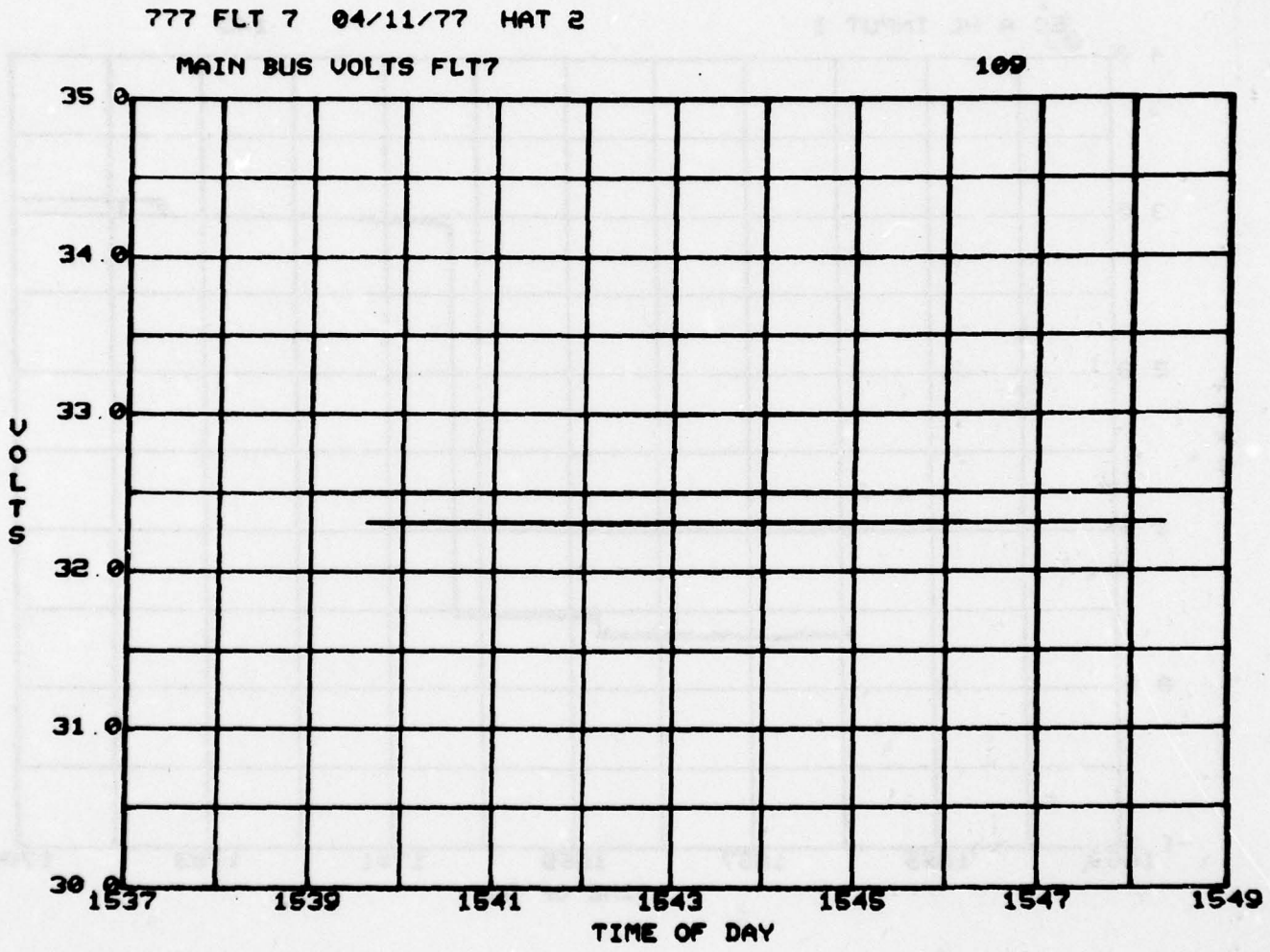
1547
1549
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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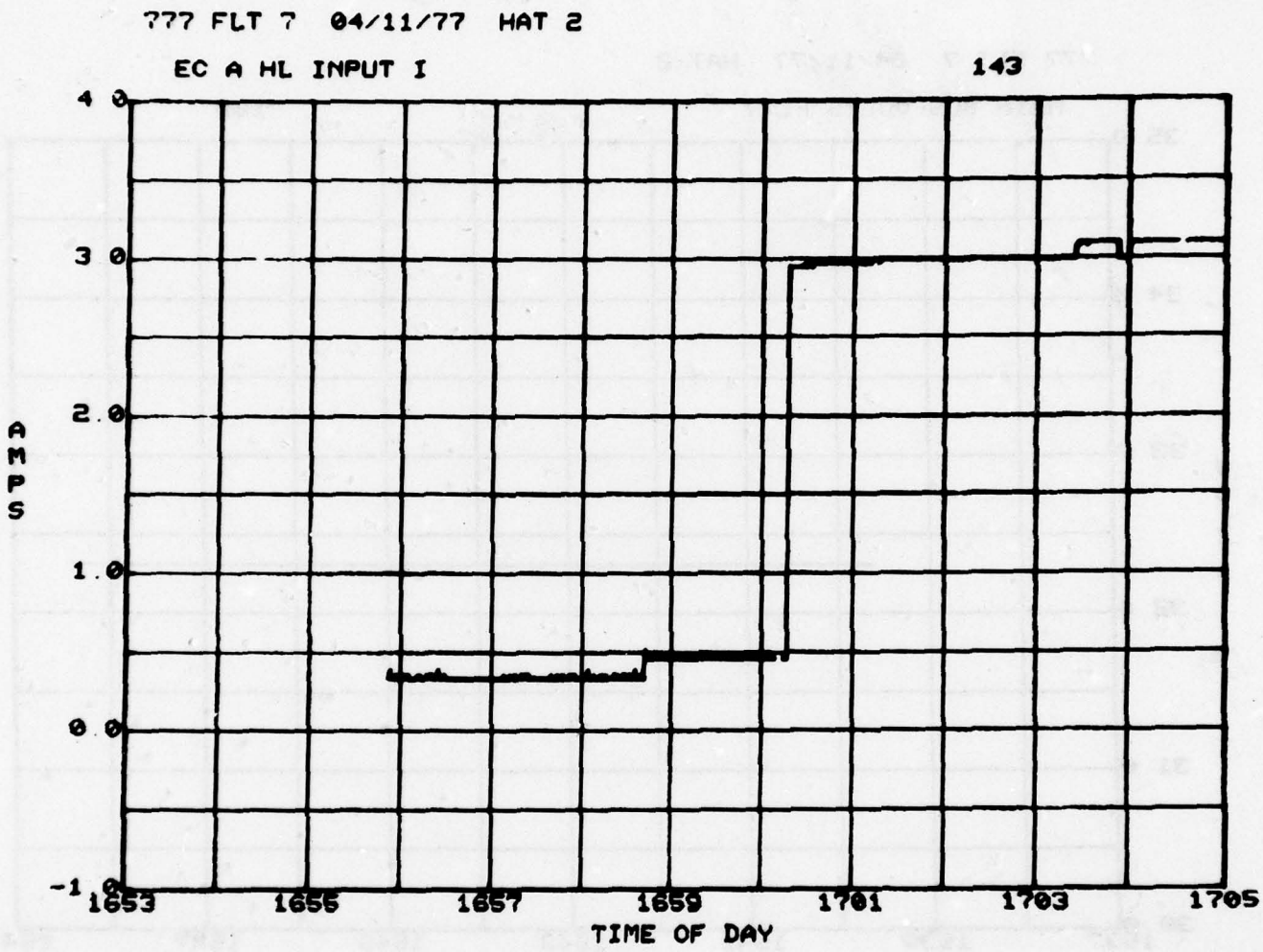
1549
TIME OF DAY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EC A HL INPUT I
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-1.0
AMPS
1653
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1657
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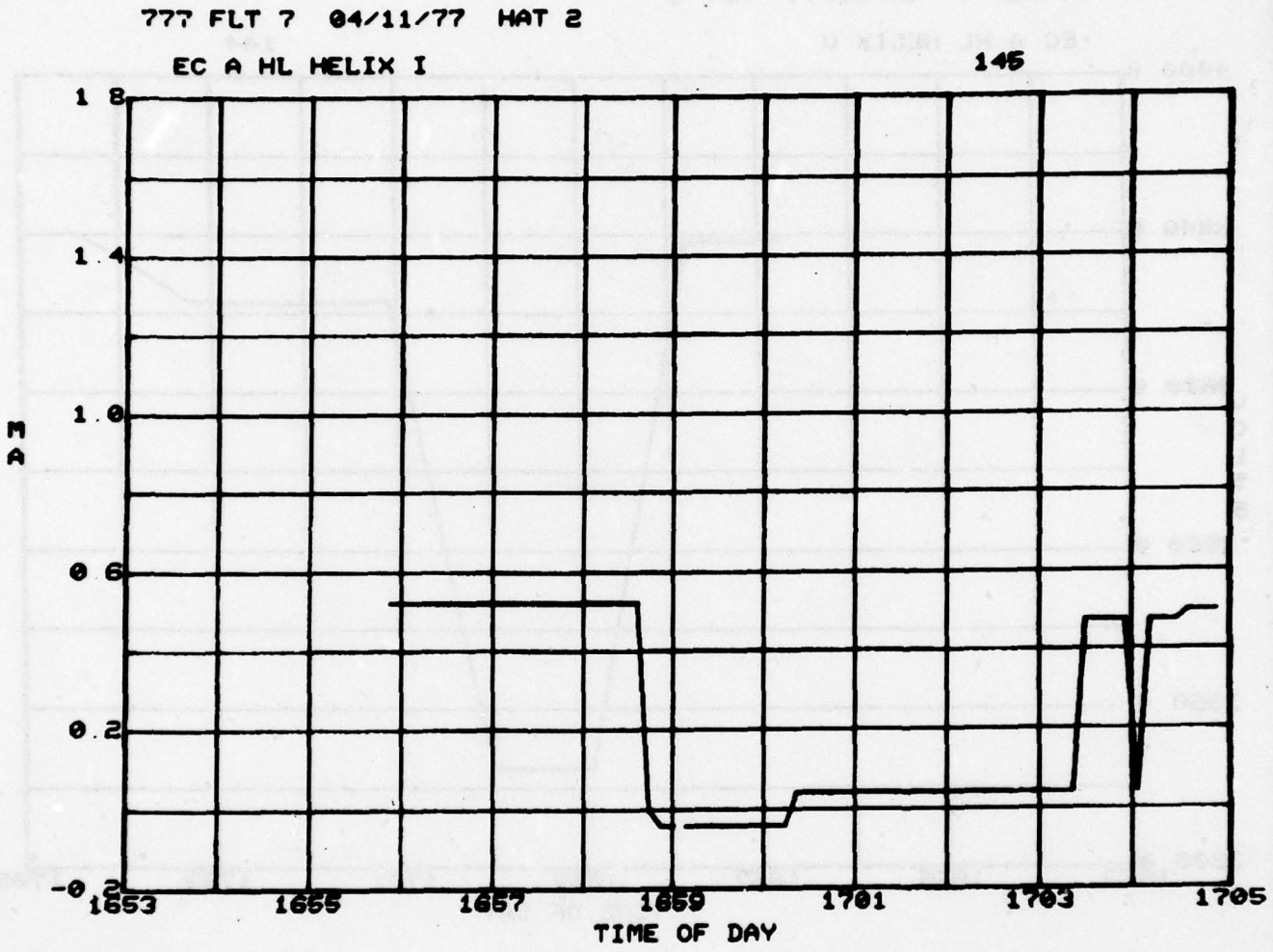
1703
1705
TIME OF DAY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1.4
1.0
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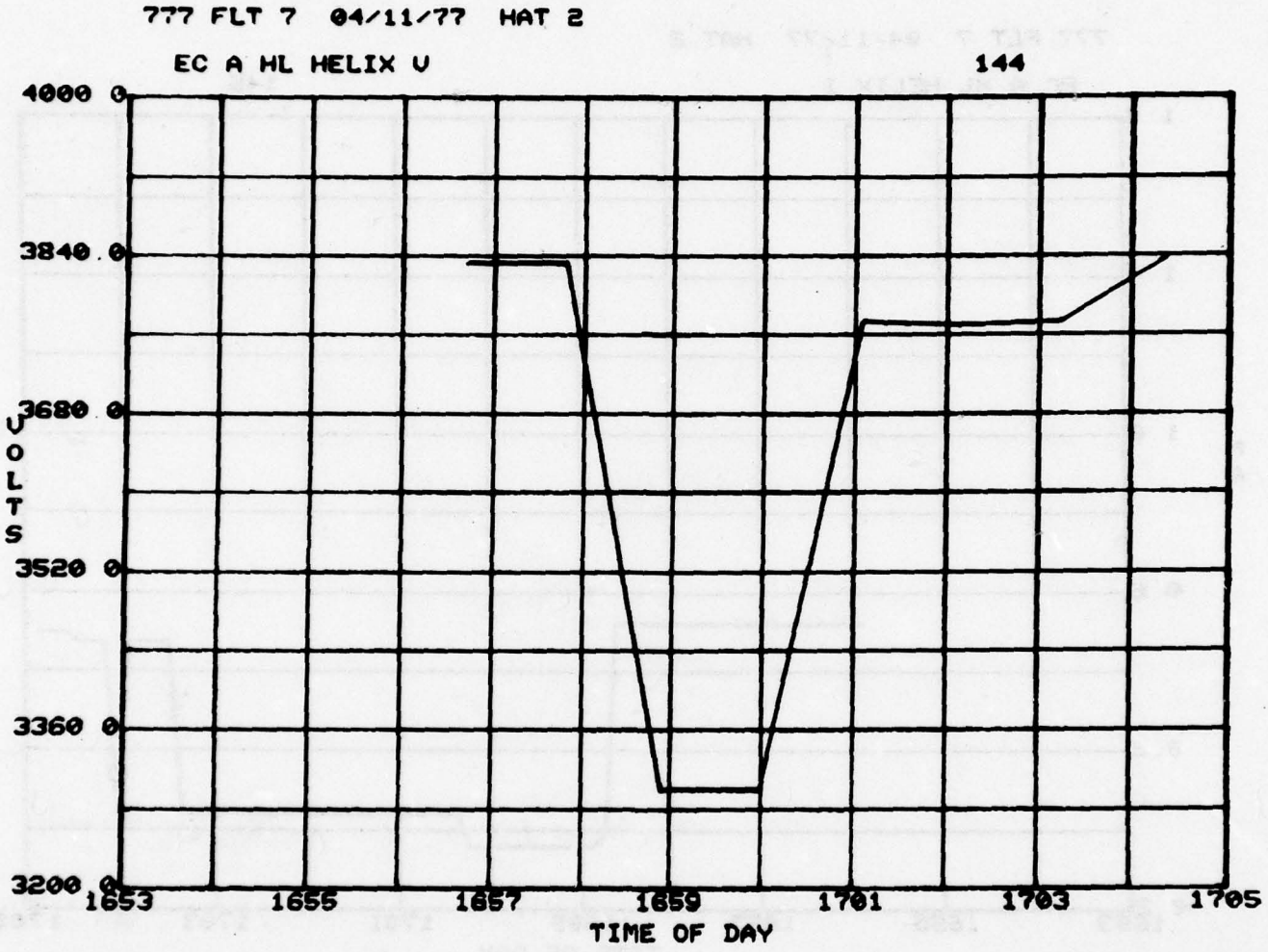
MA
1653
1655
1657
1659
1701
1703
1705
TIME OF DAY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1653
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1659
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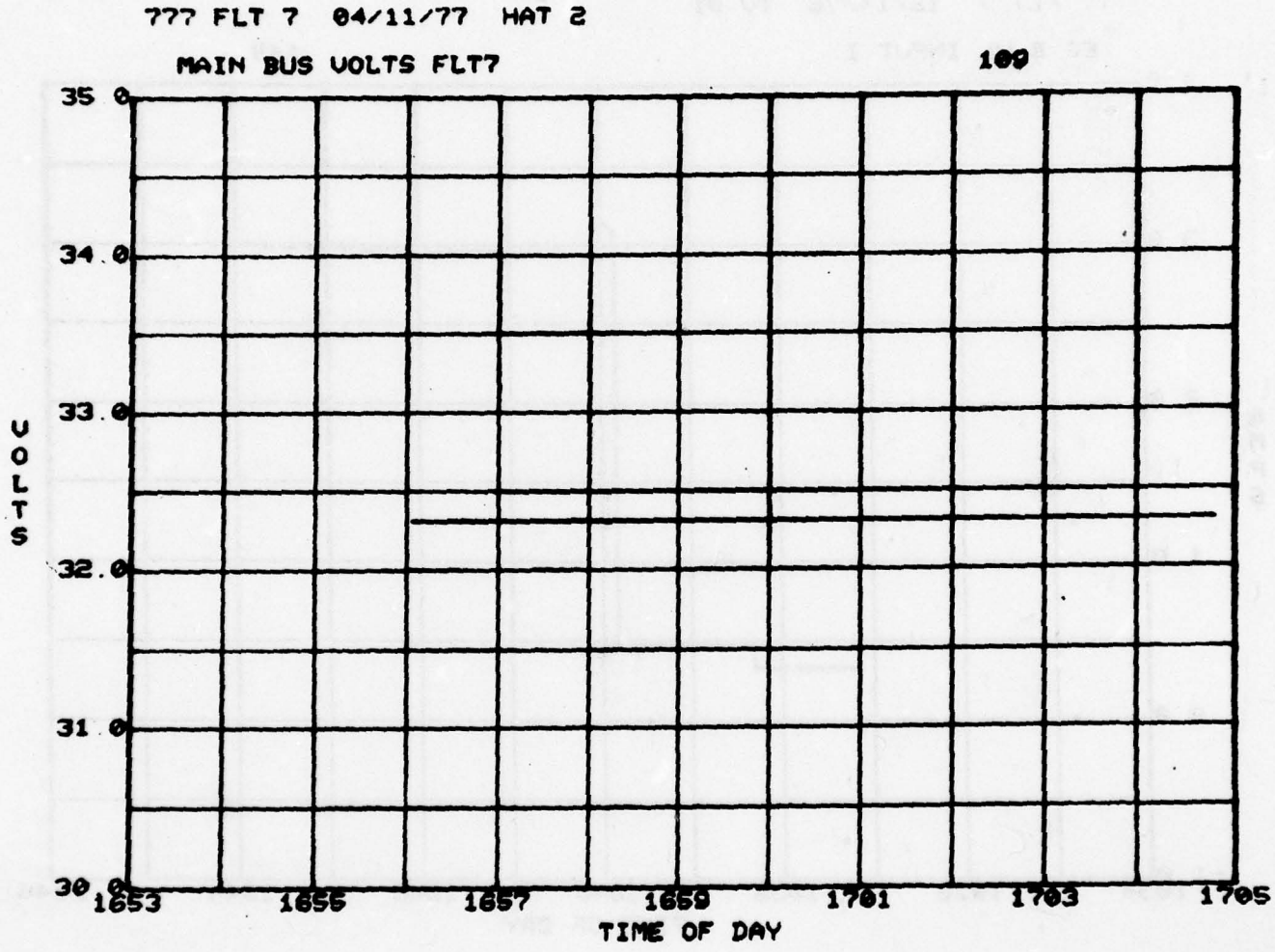
1703
1705
TIME OF DAY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VOLTS
1653
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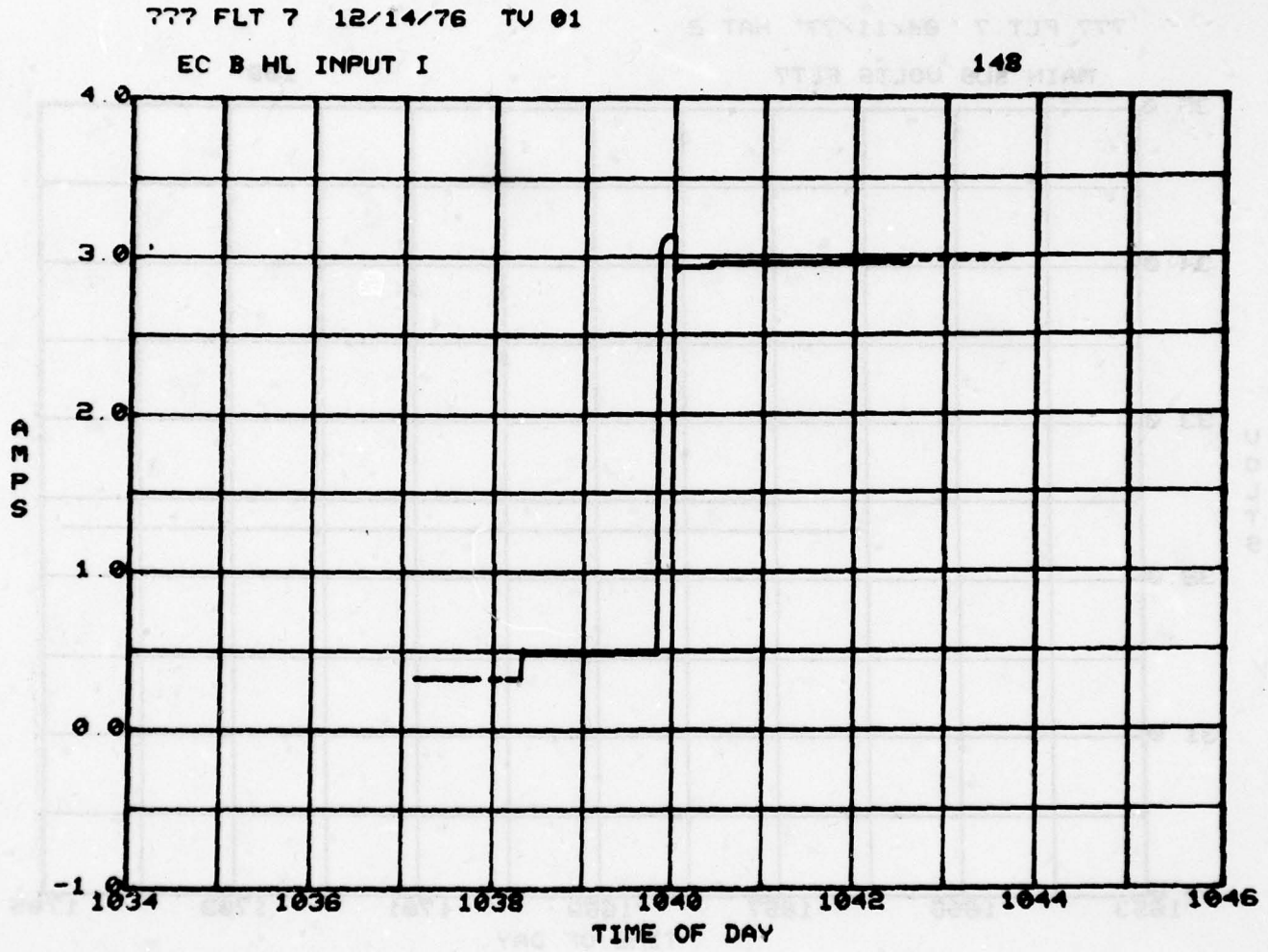
1659
1701
1703
1705
TIME OF DAY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3.0
2.0
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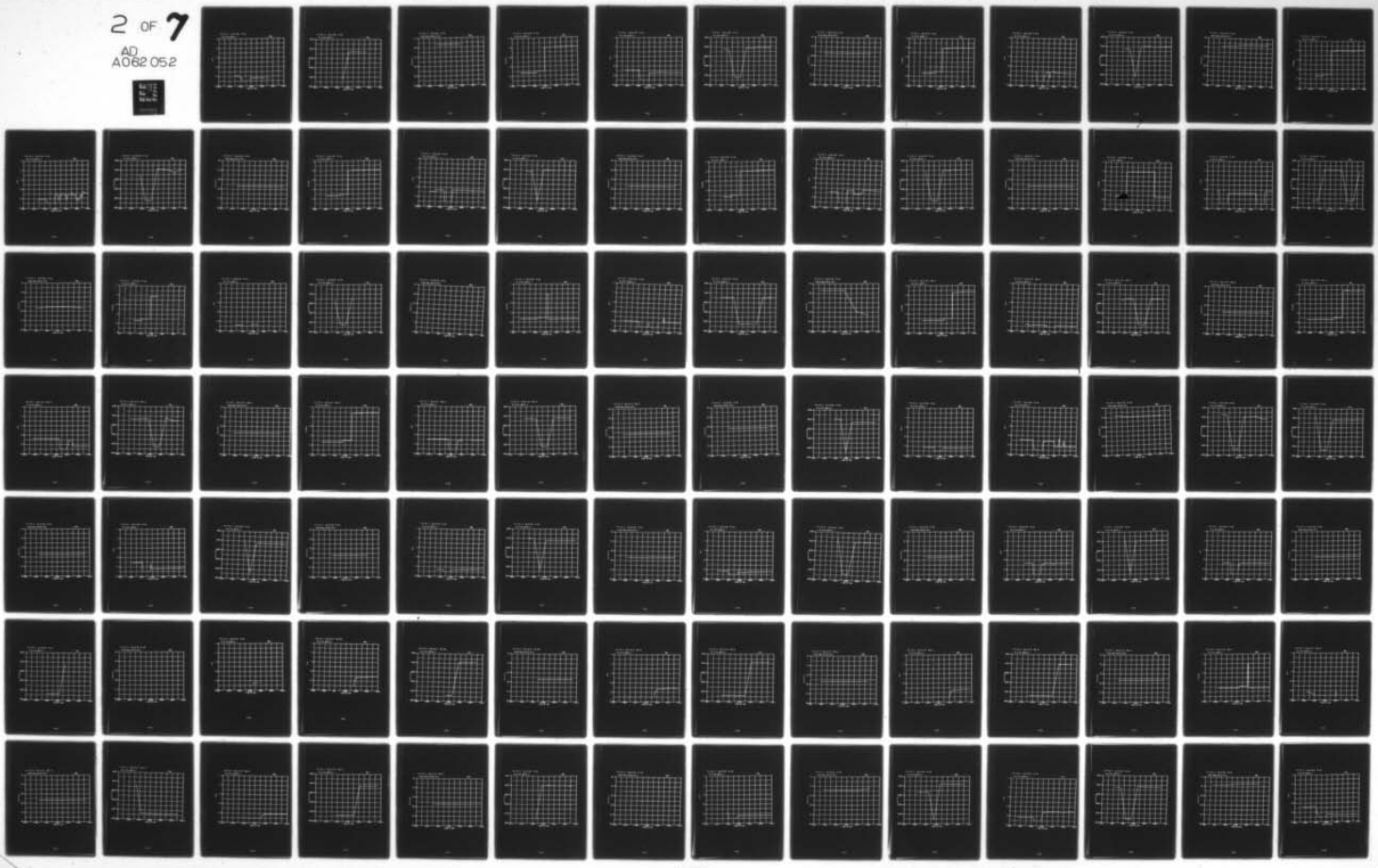
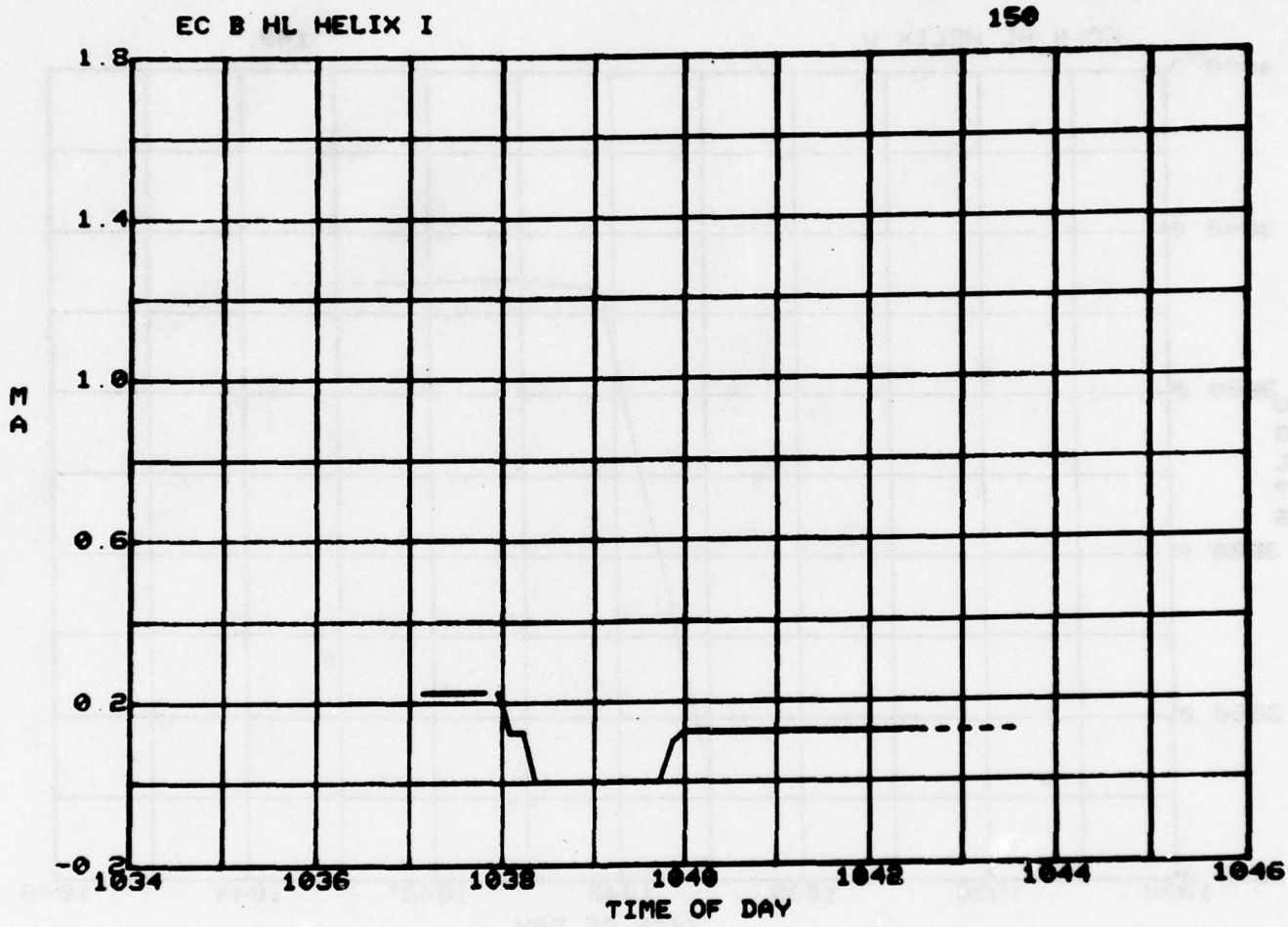
-1.0
AMPS
1034
1036
1038
1040
1042
1044
1046
TIME OF DAY

AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

2 OF 7
AD A062 052

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M
A
1034
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1038
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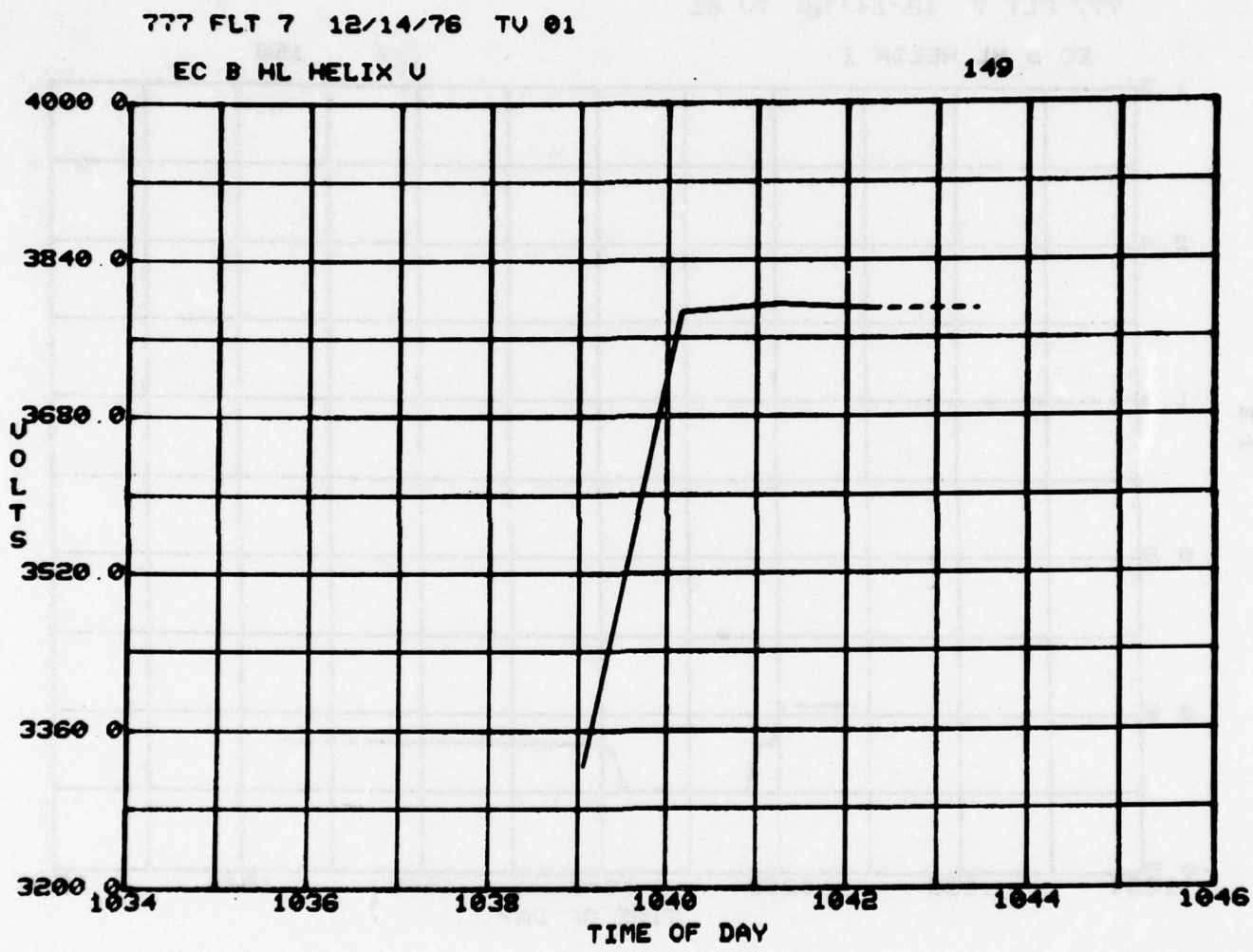
TIME OF DAY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4000 0
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VOLTS
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1038
1040
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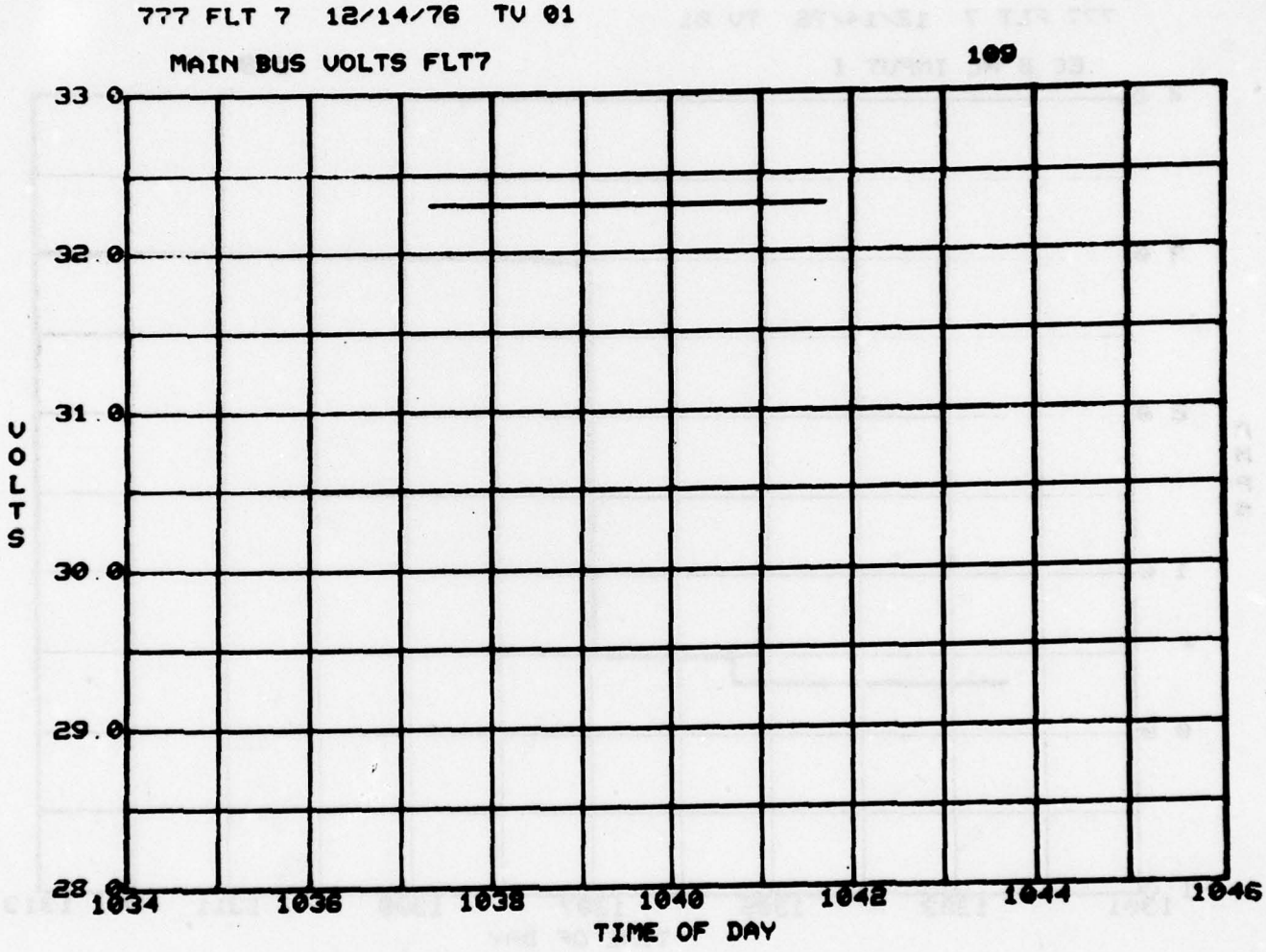
1044
1046
TIME OF DAY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MAIN BUS VOLTS FLT7
109
33.0
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VOLTS
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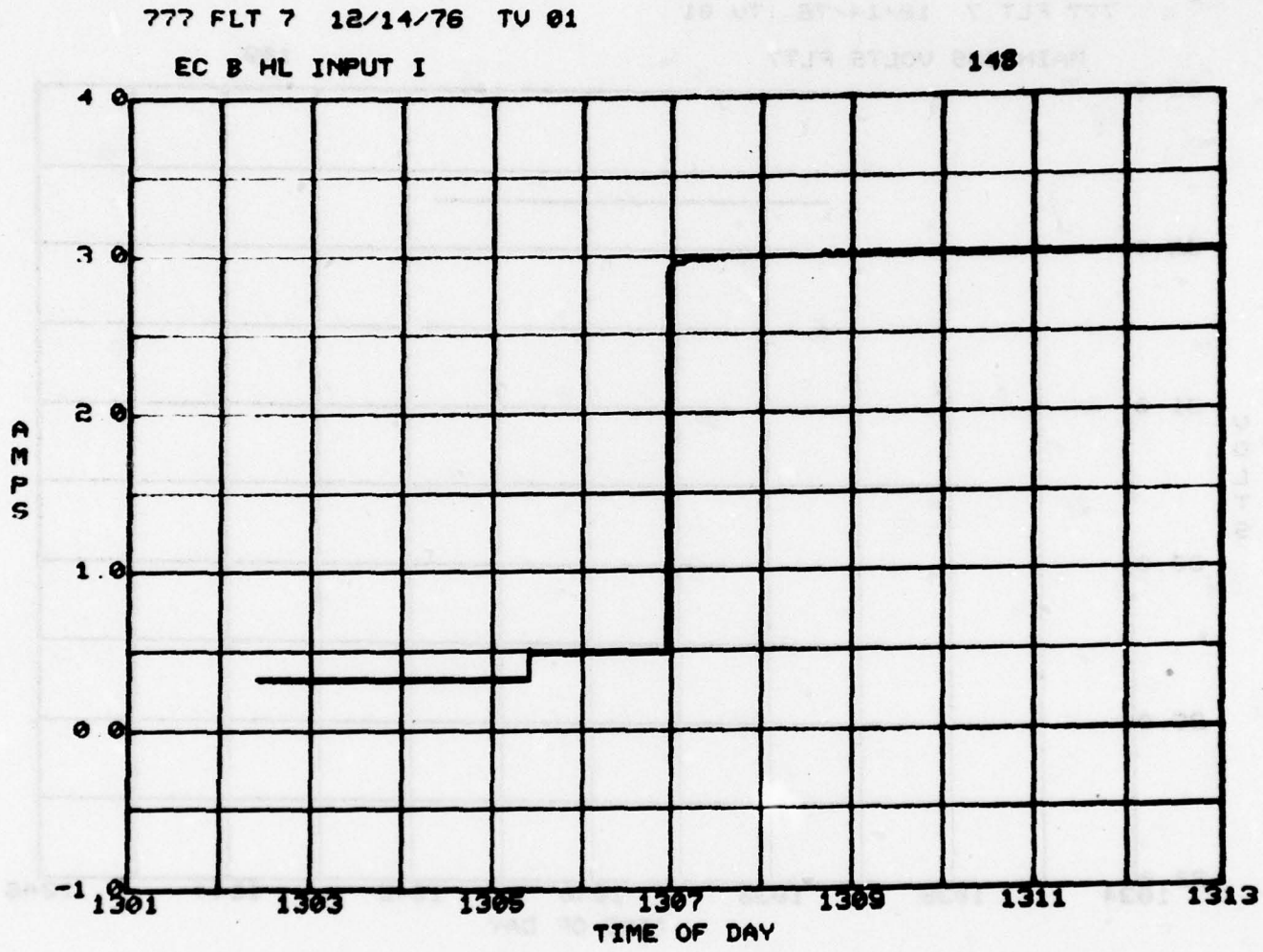
TIME OF DAY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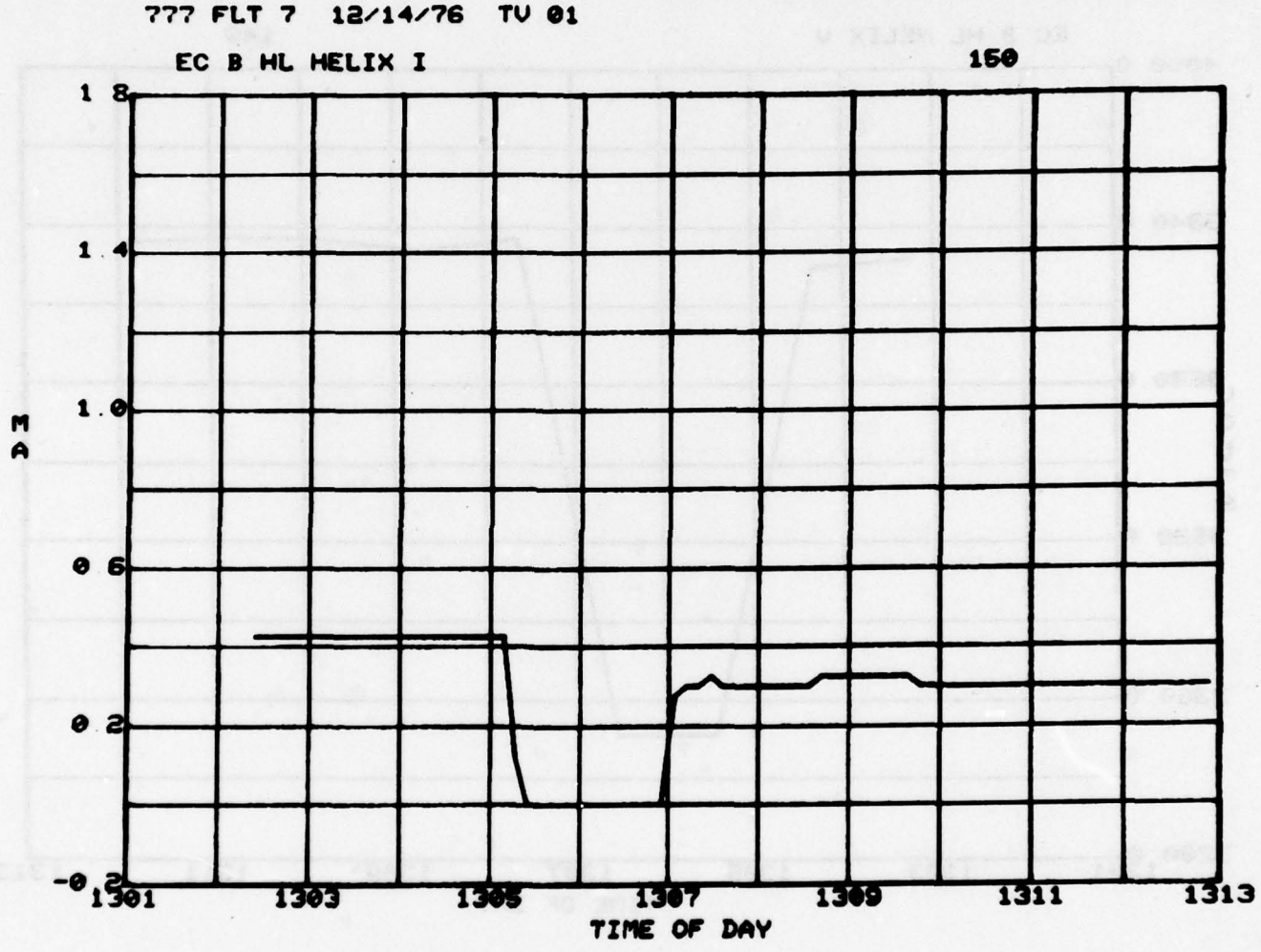
TIME OF DAY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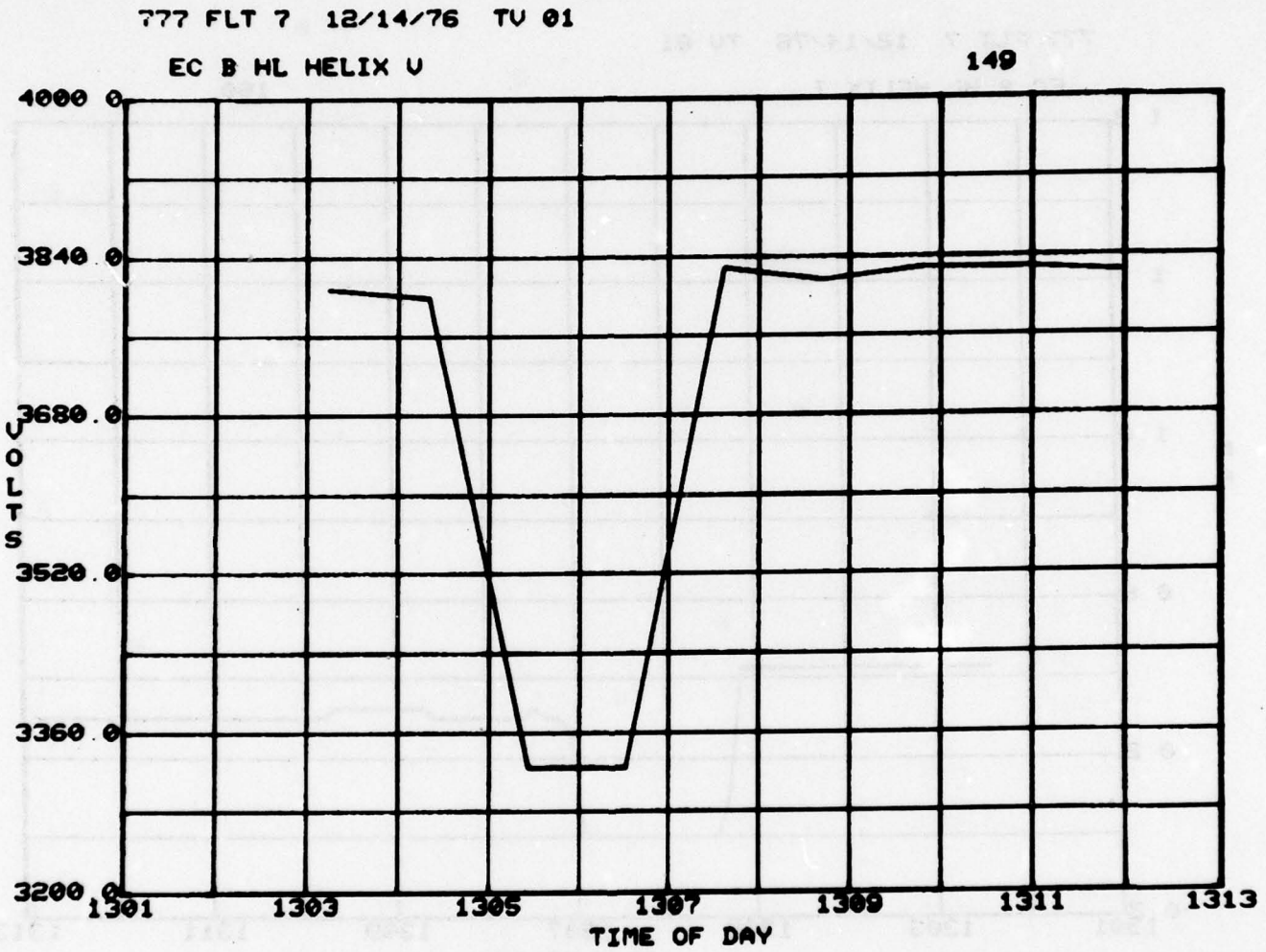
TIME OF DAY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VOLTS
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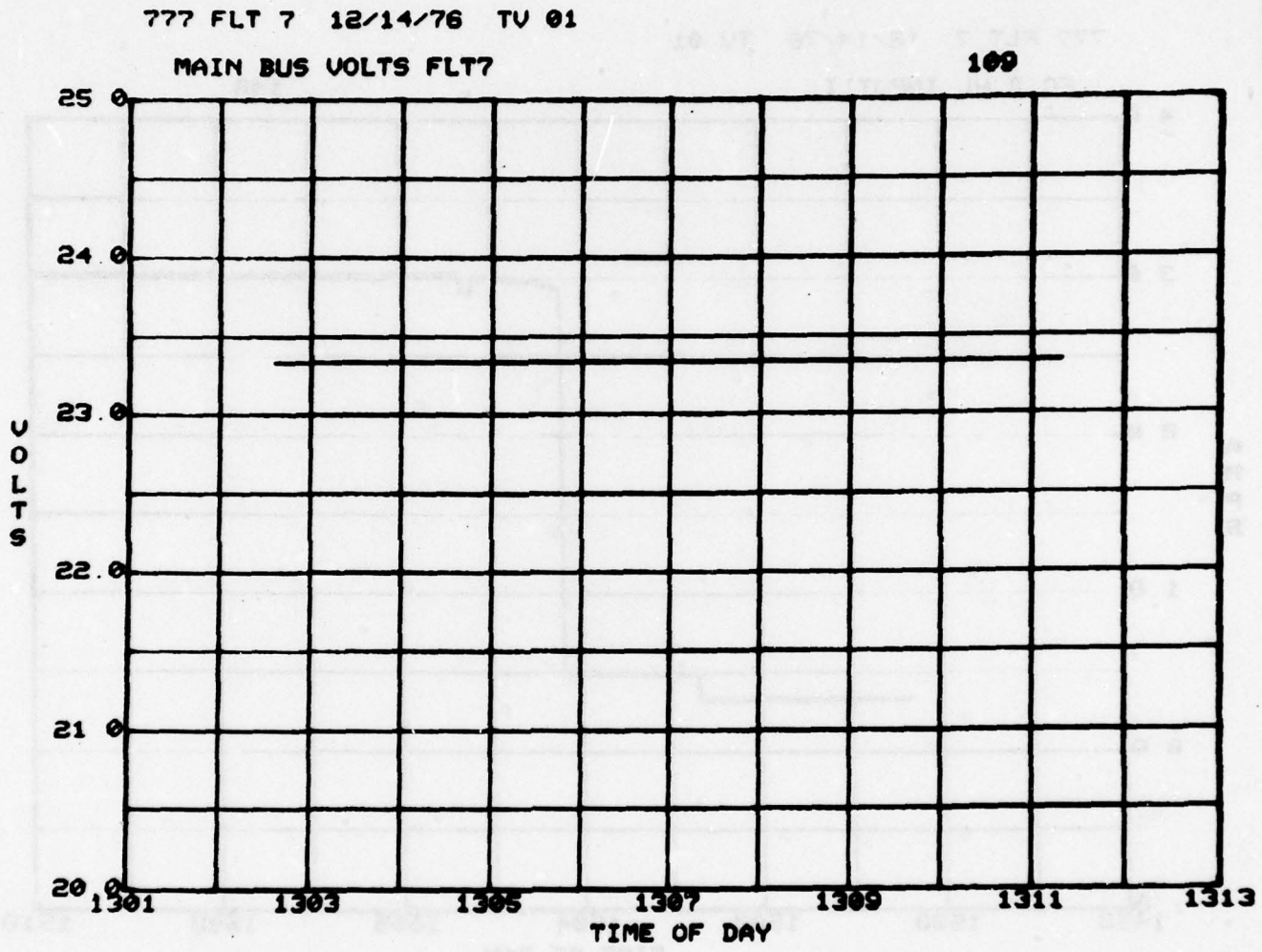
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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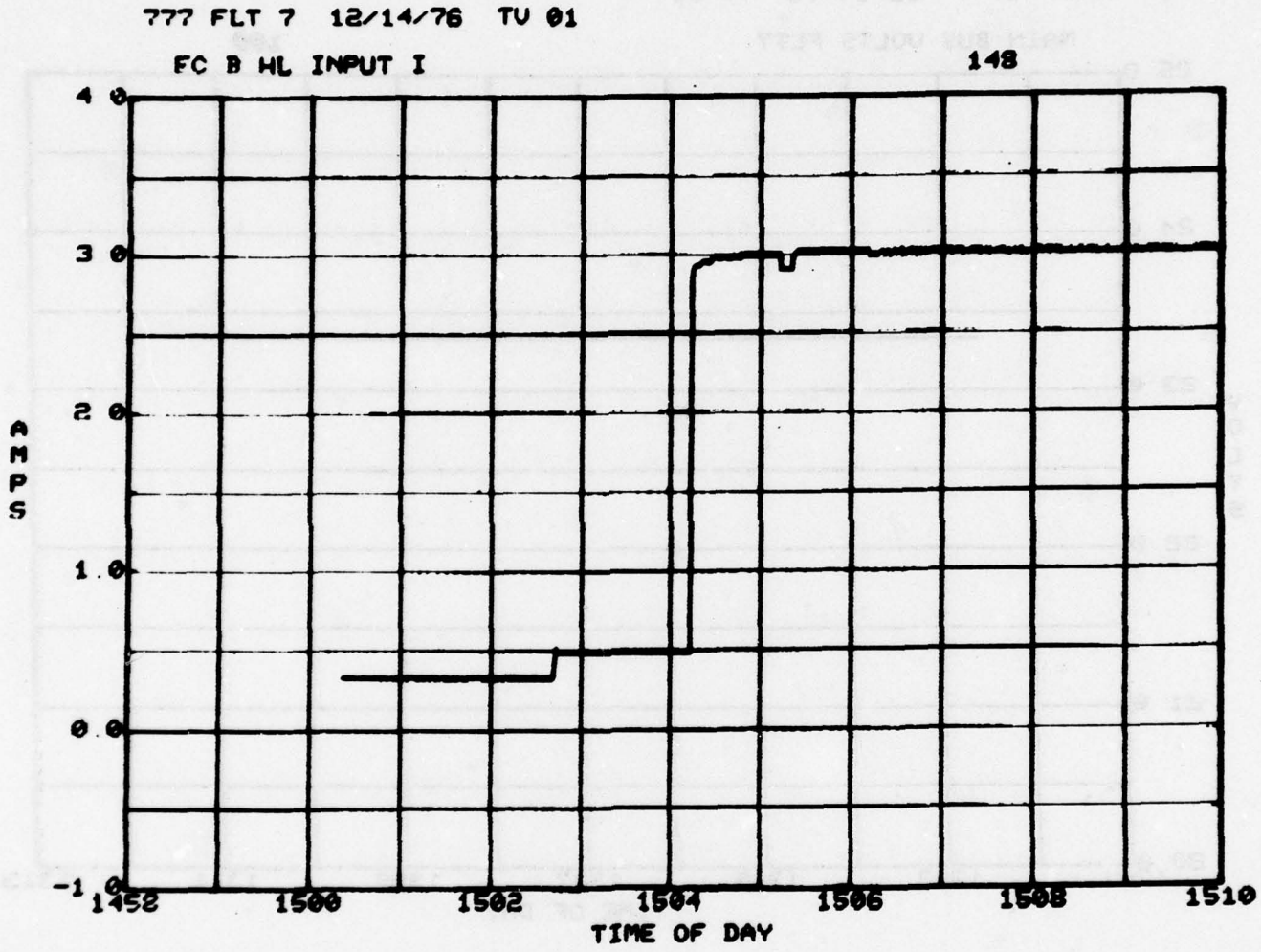
TIME OF DAY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FC B HL INPUT I
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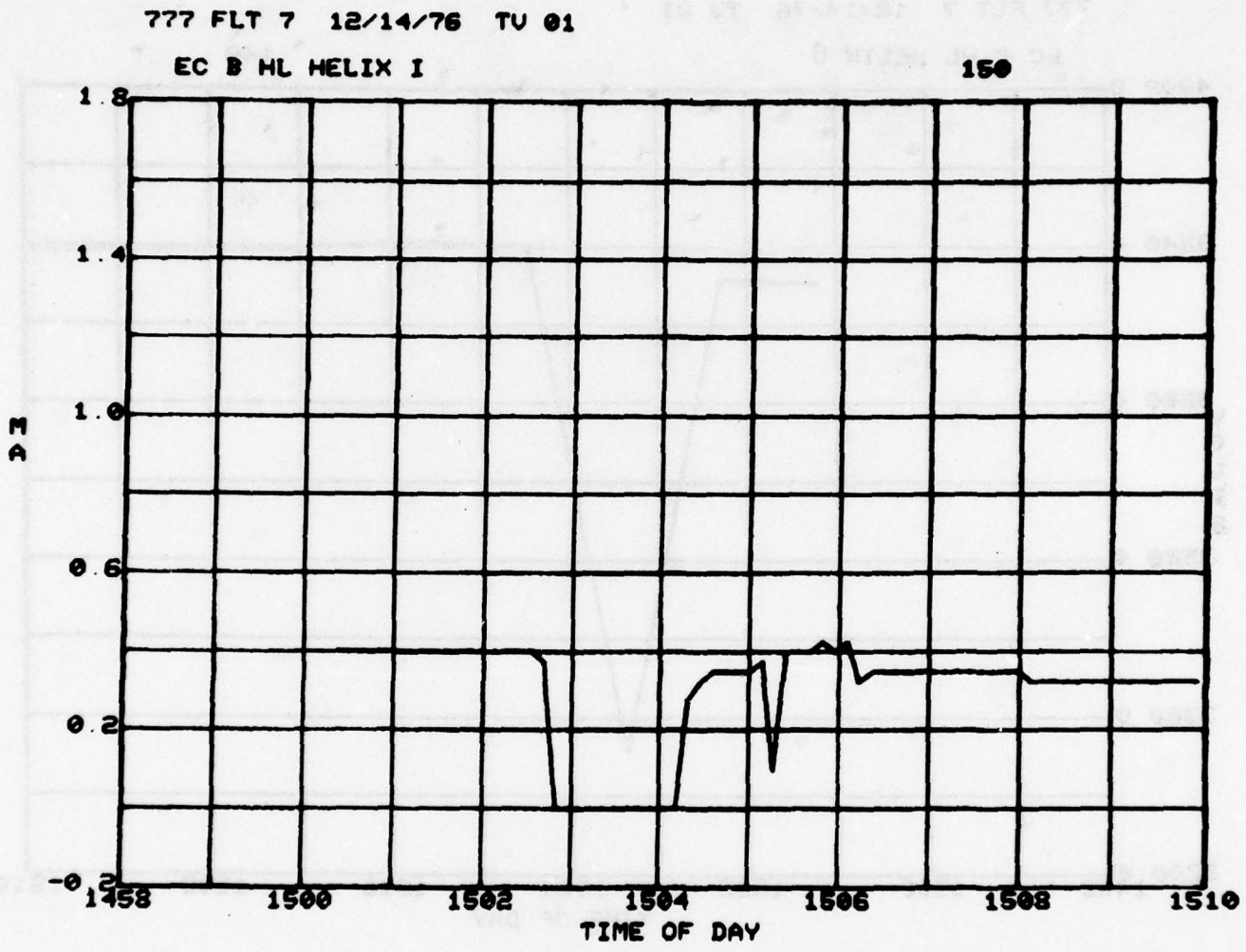
TIME OF DAY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MA
1458
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1502
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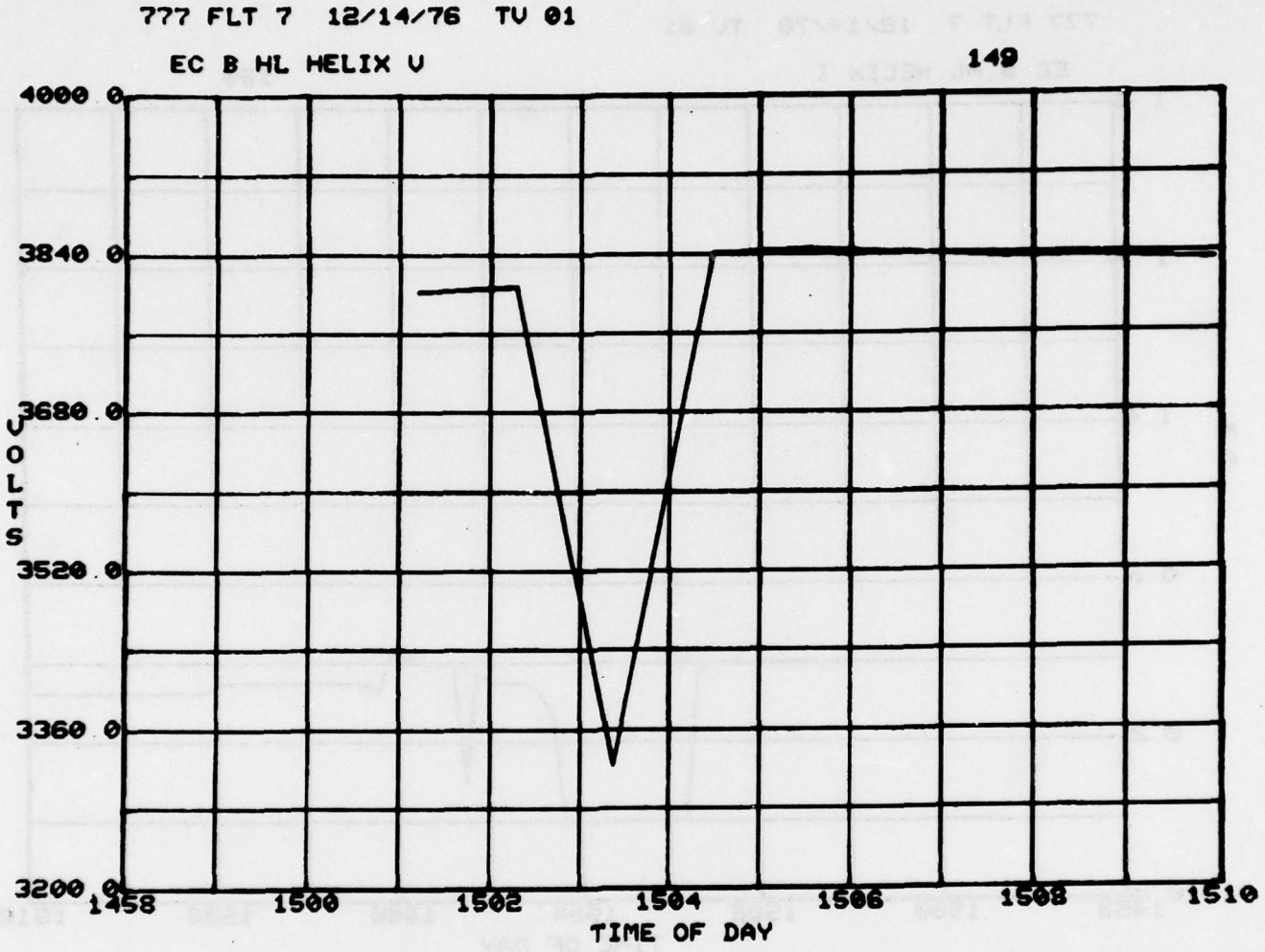
TIME OF DAY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VOLTS
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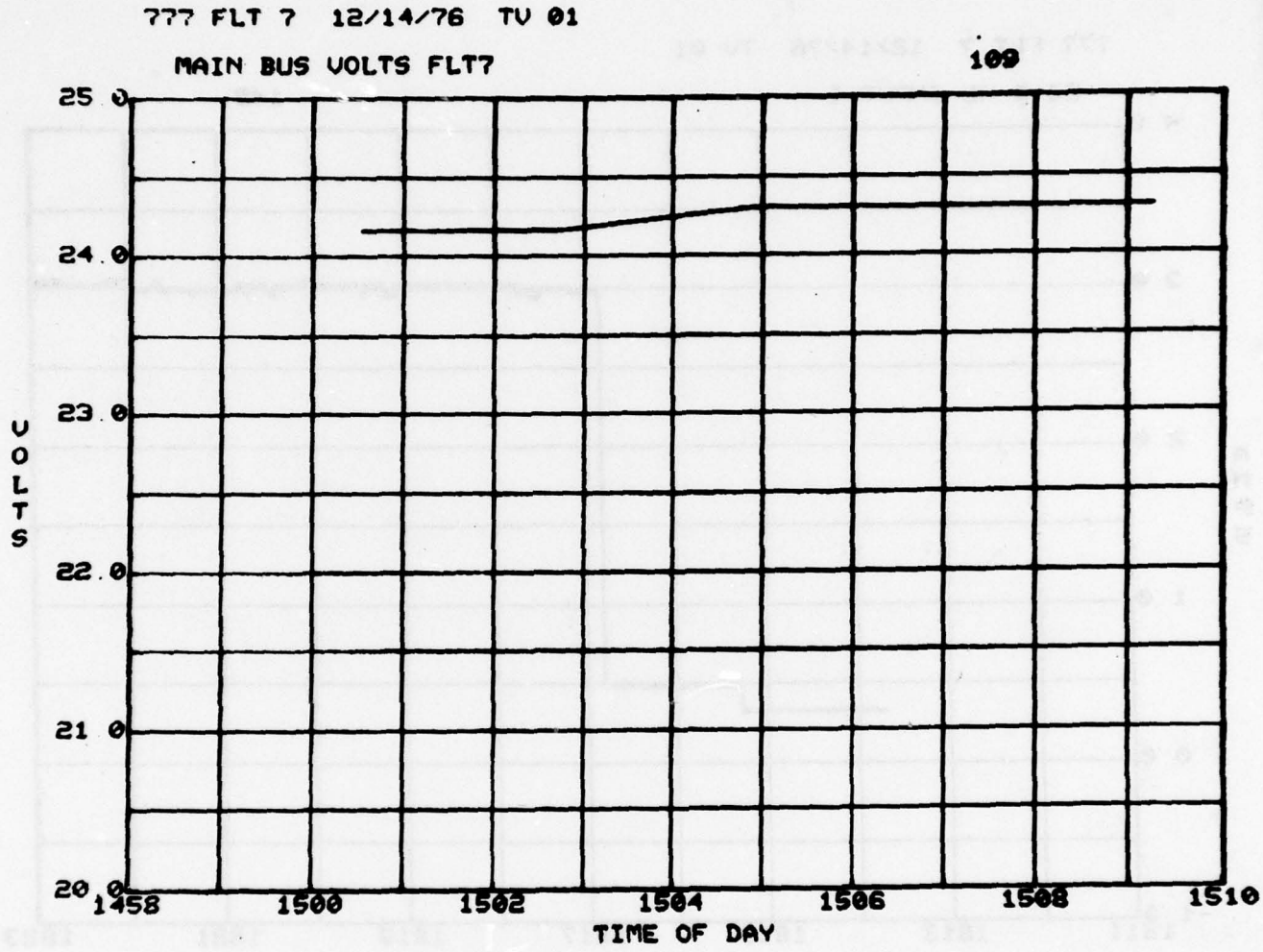
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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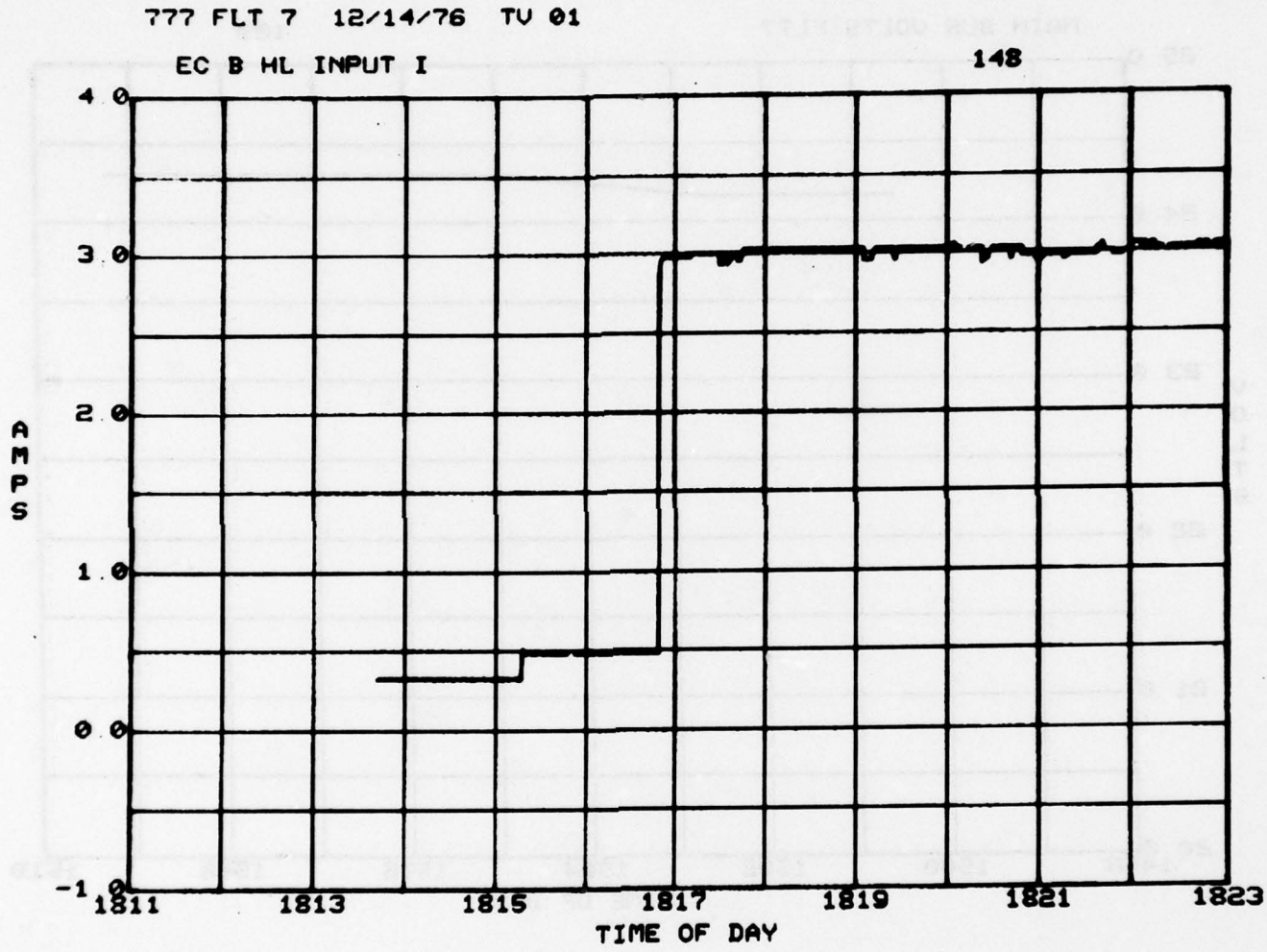
TIME OF DAY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EC B HL INPUT I
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AMPS
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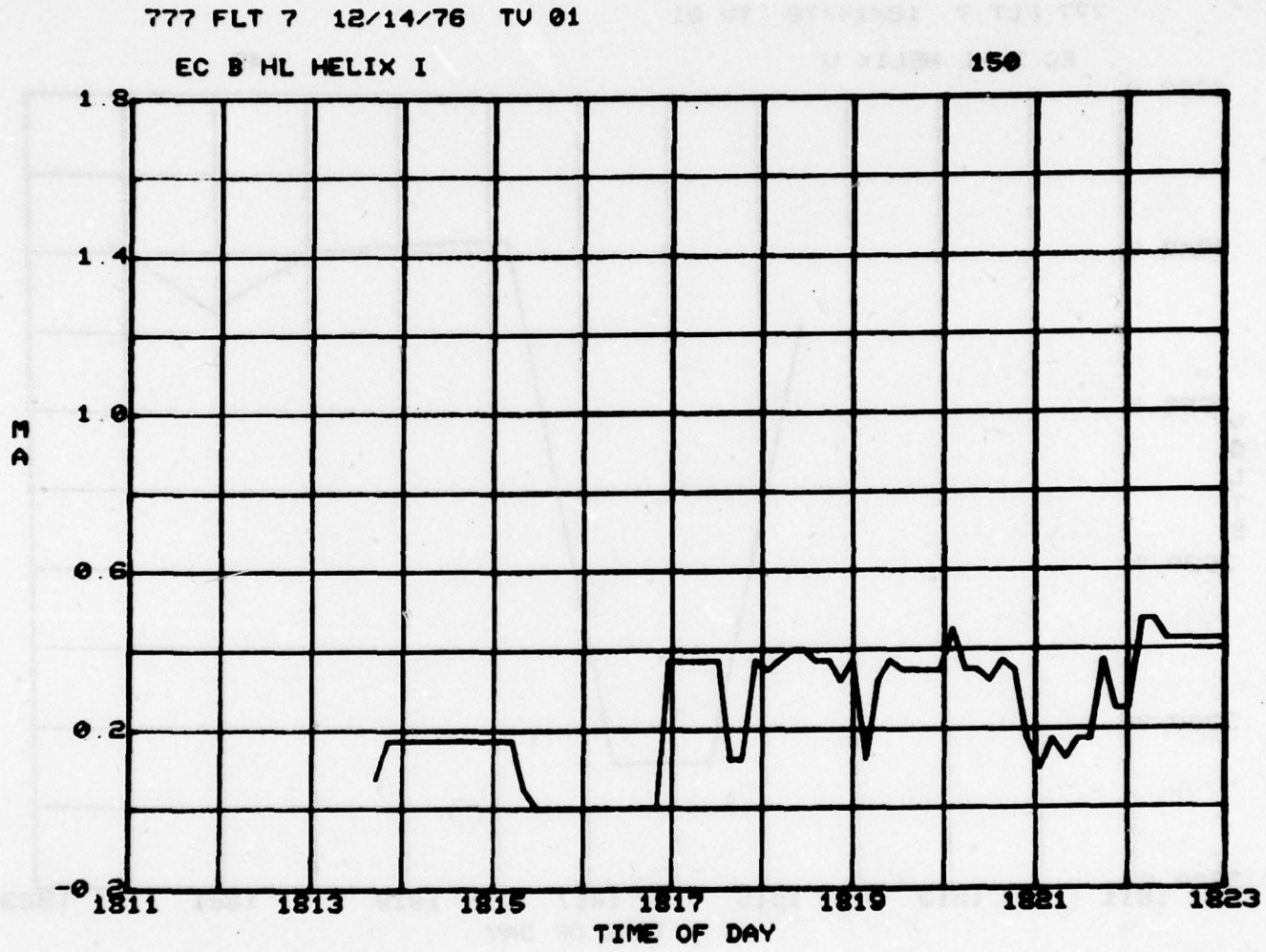
TIME OF DAY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MA
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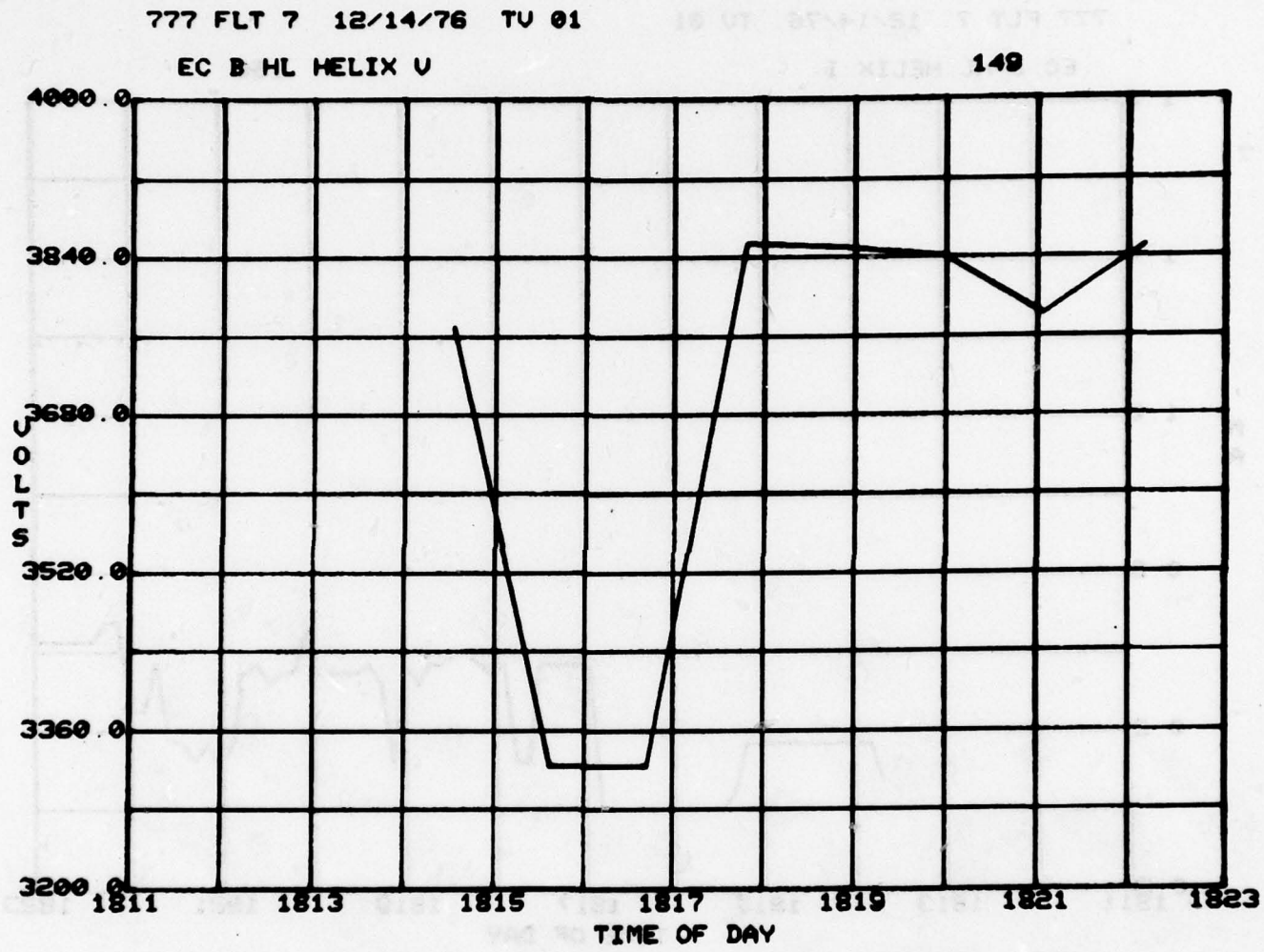
TIME OF DAY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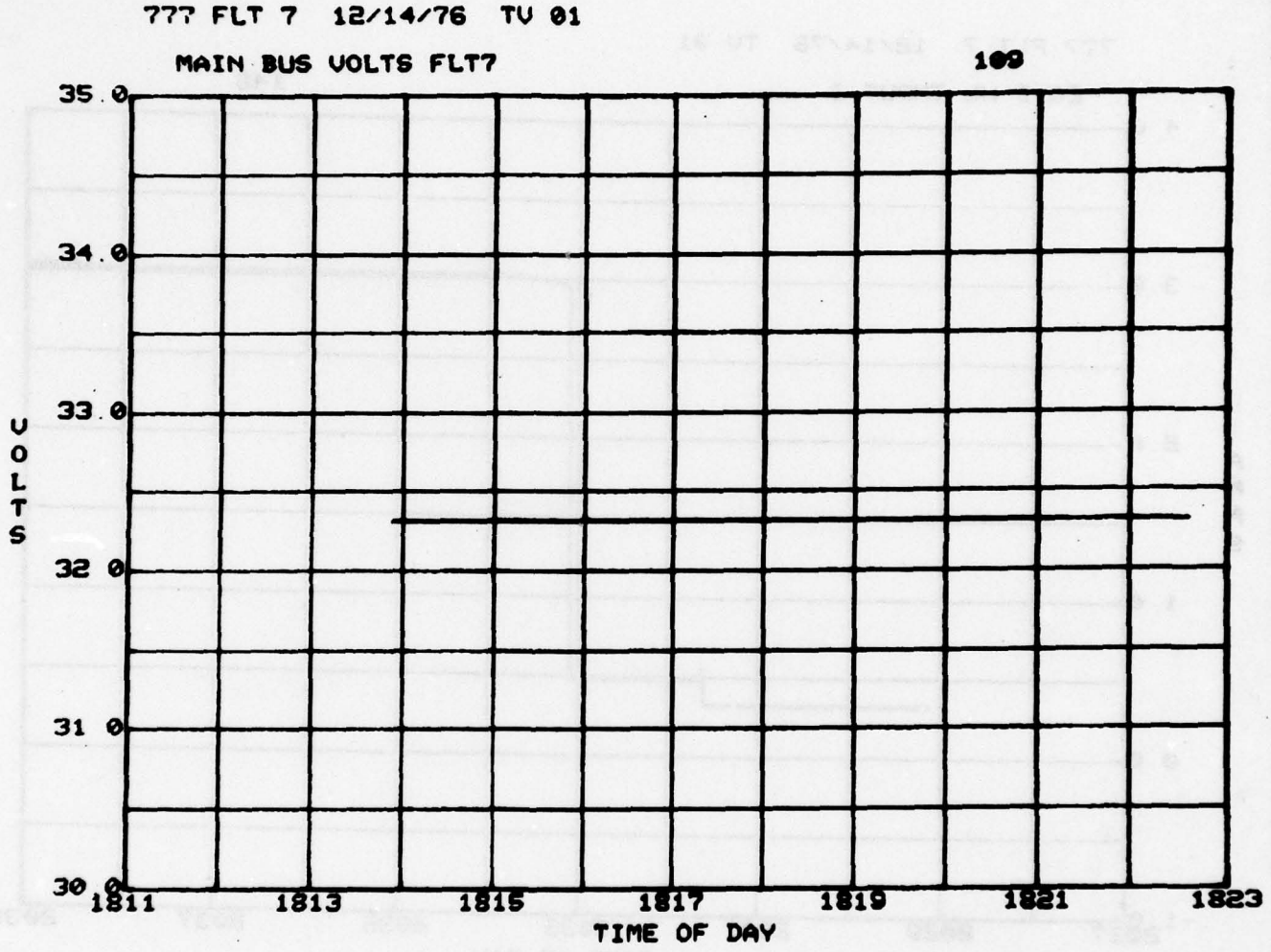
TIME OF DAY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VOLTS
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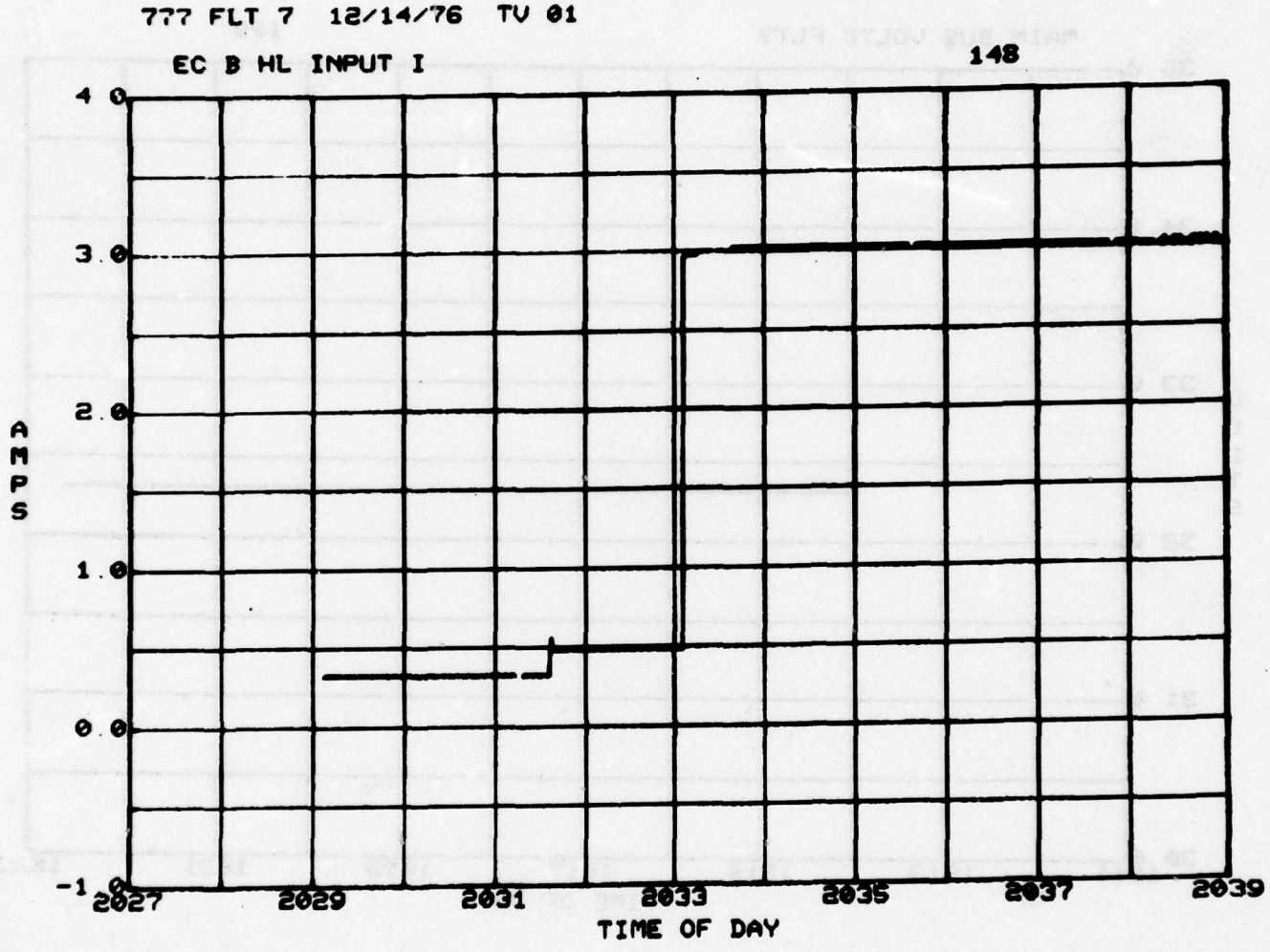
TIME OF DAY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AMPS
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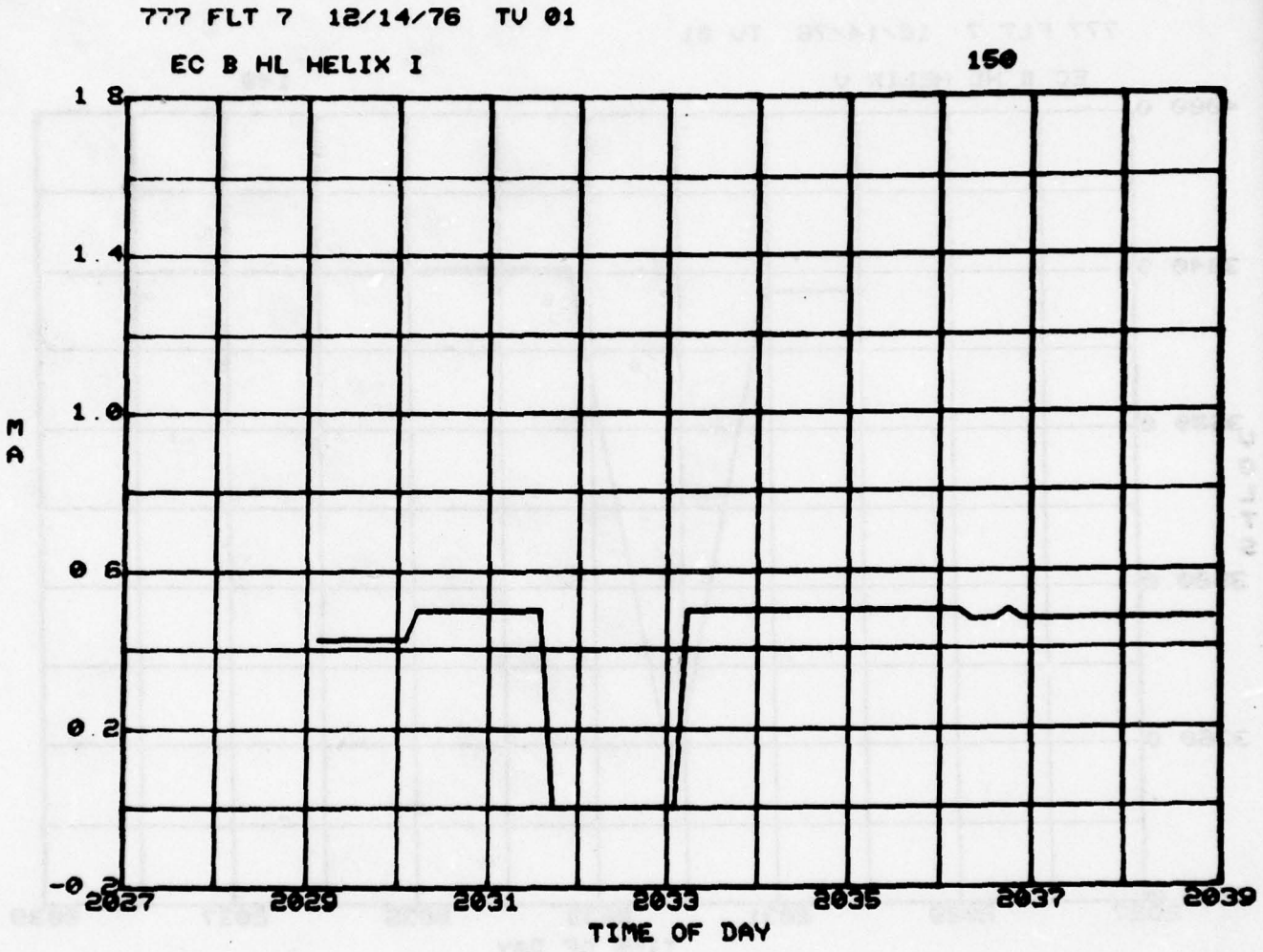
TIME OF DAY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0 2
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MA
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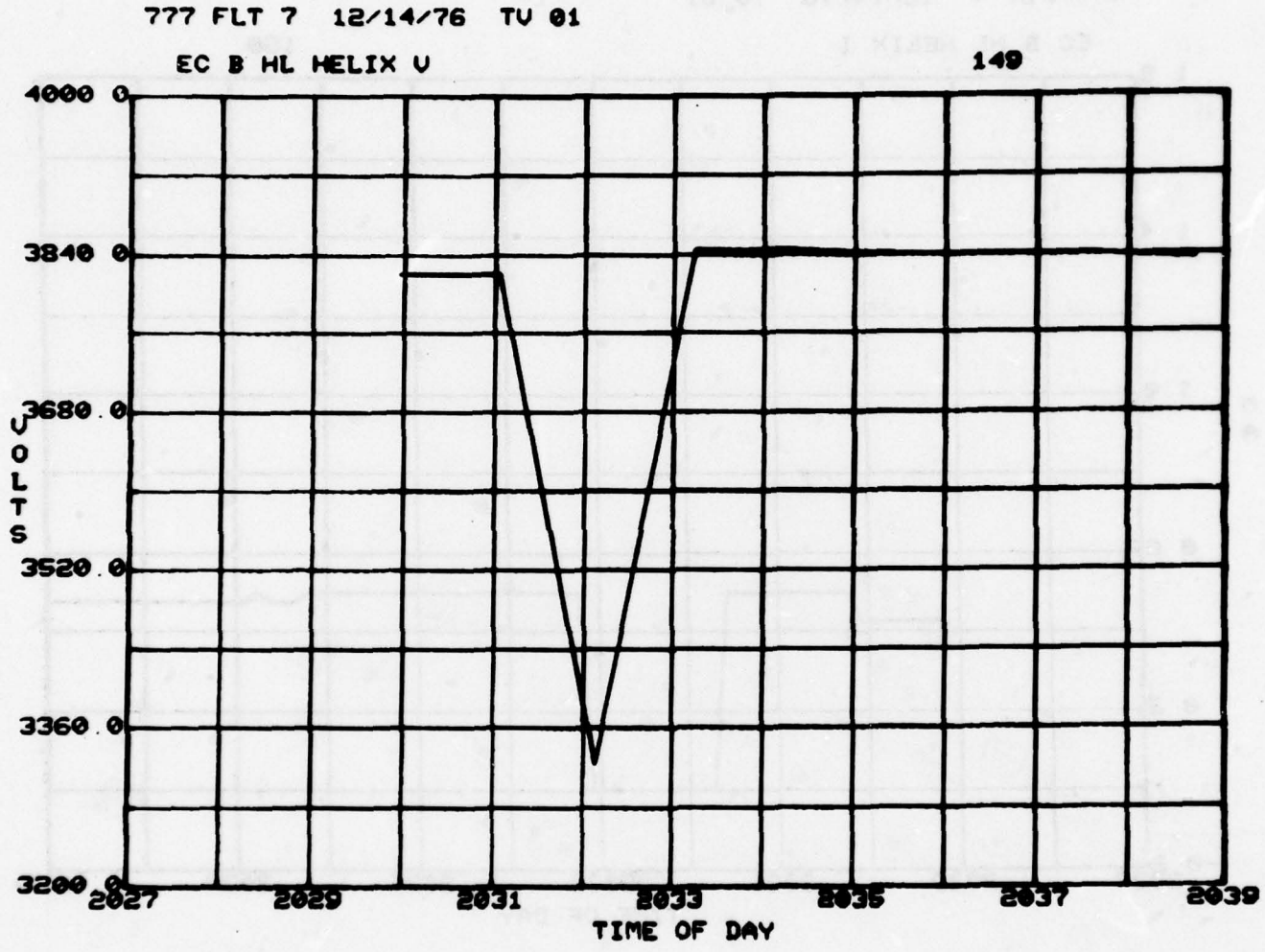
TIME OF DAY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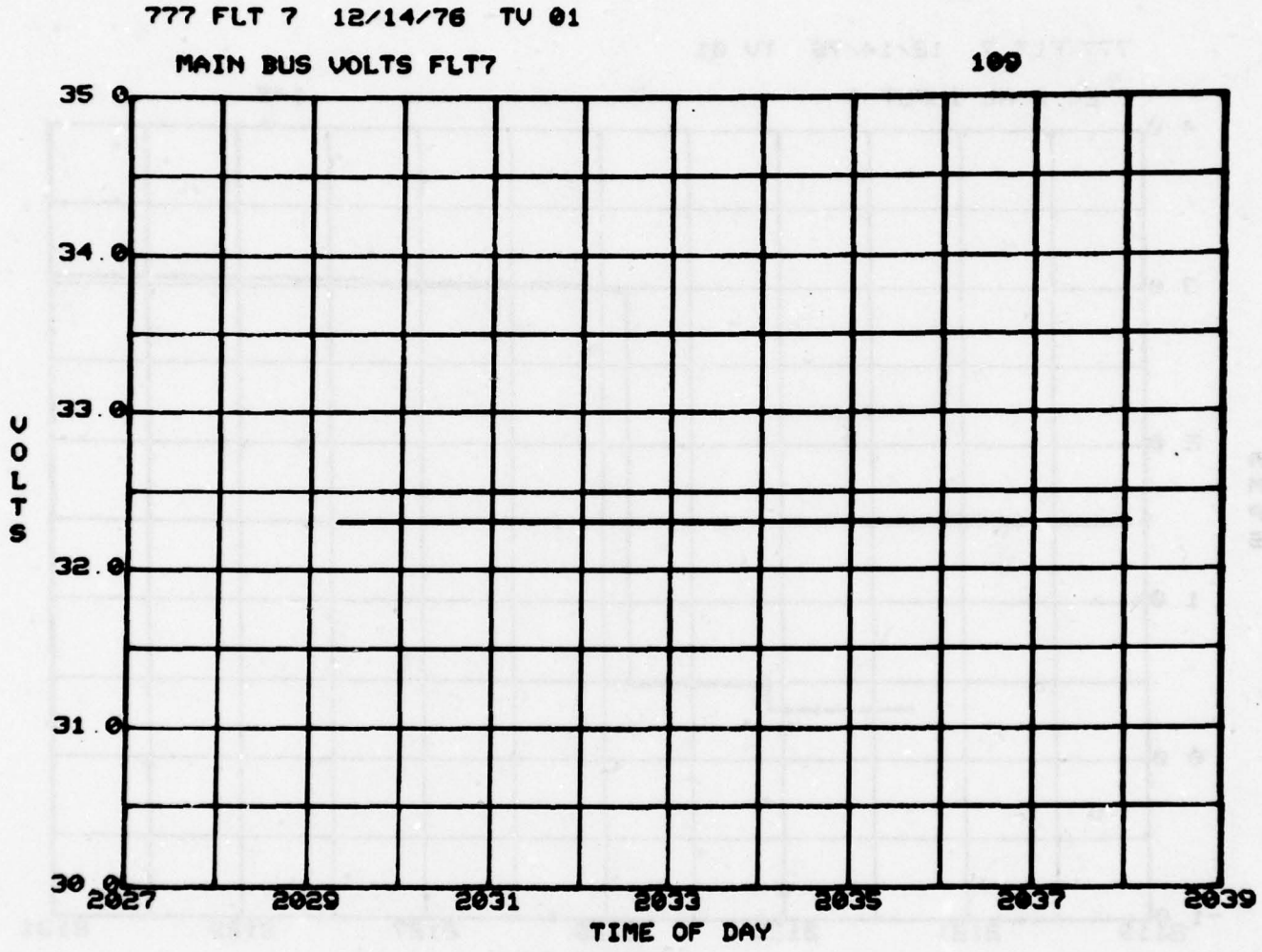
TIME OF DAY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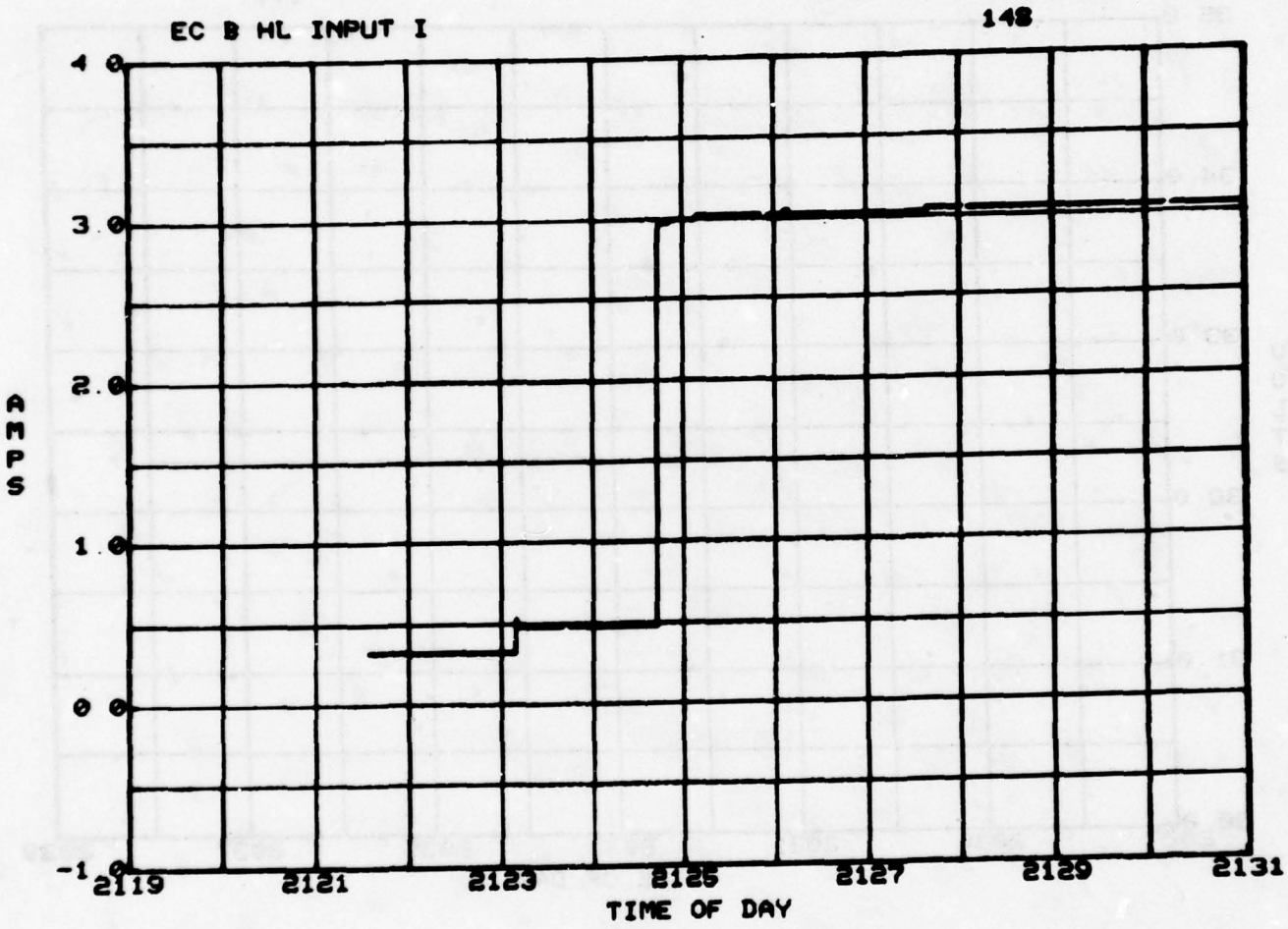
TIME OF DAY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AMPS
2119
2121
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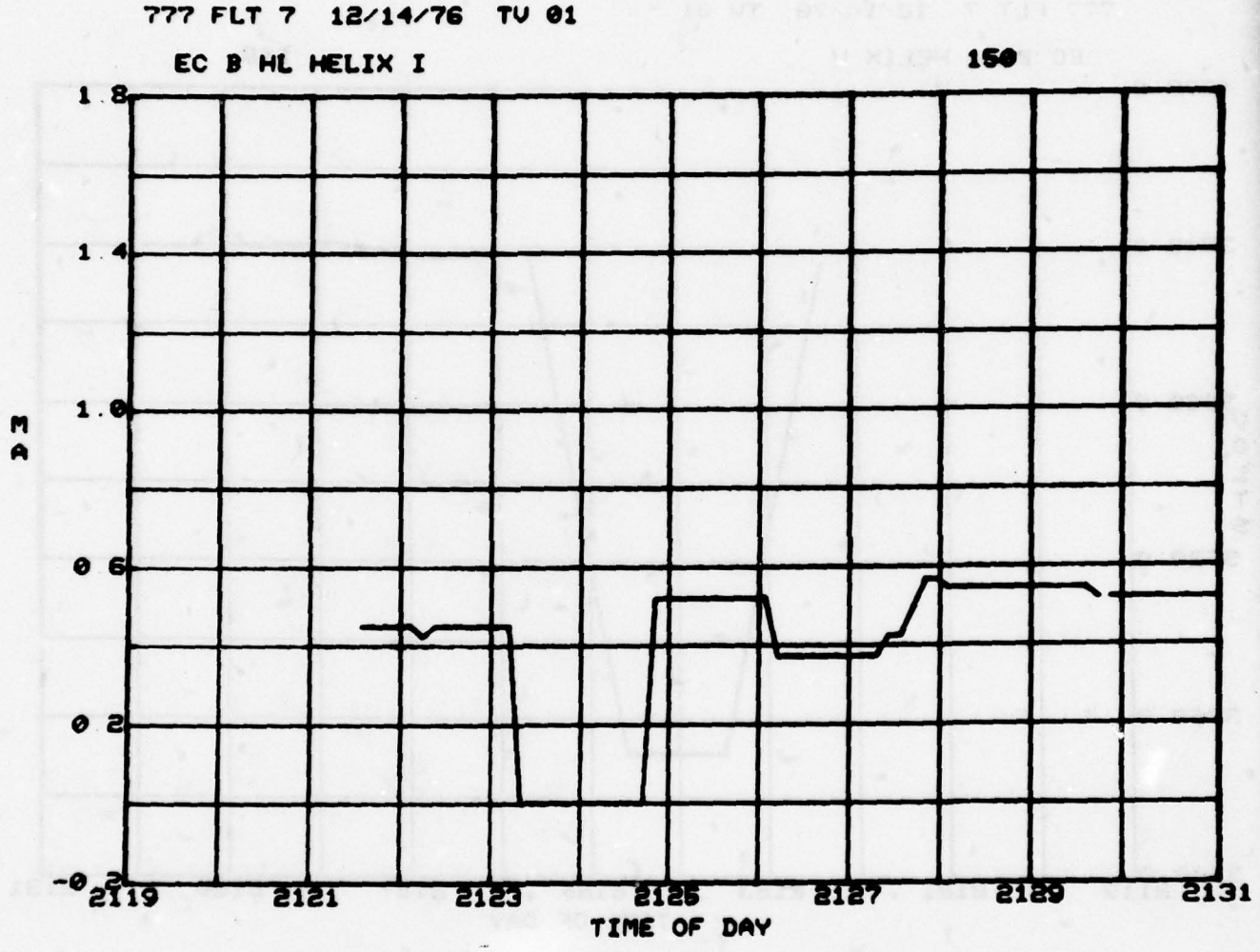
TIME OF DAY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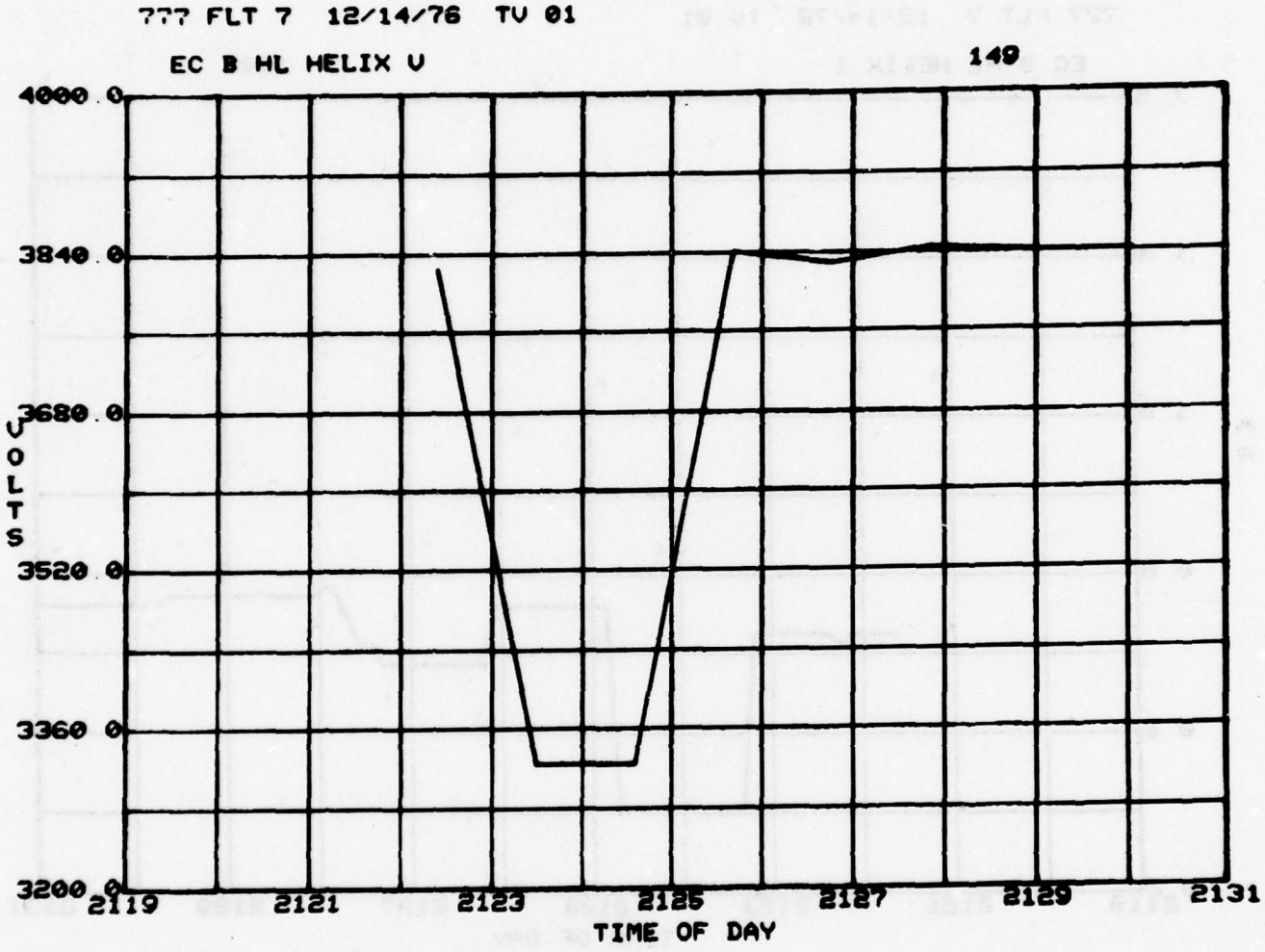
TIME OF DAY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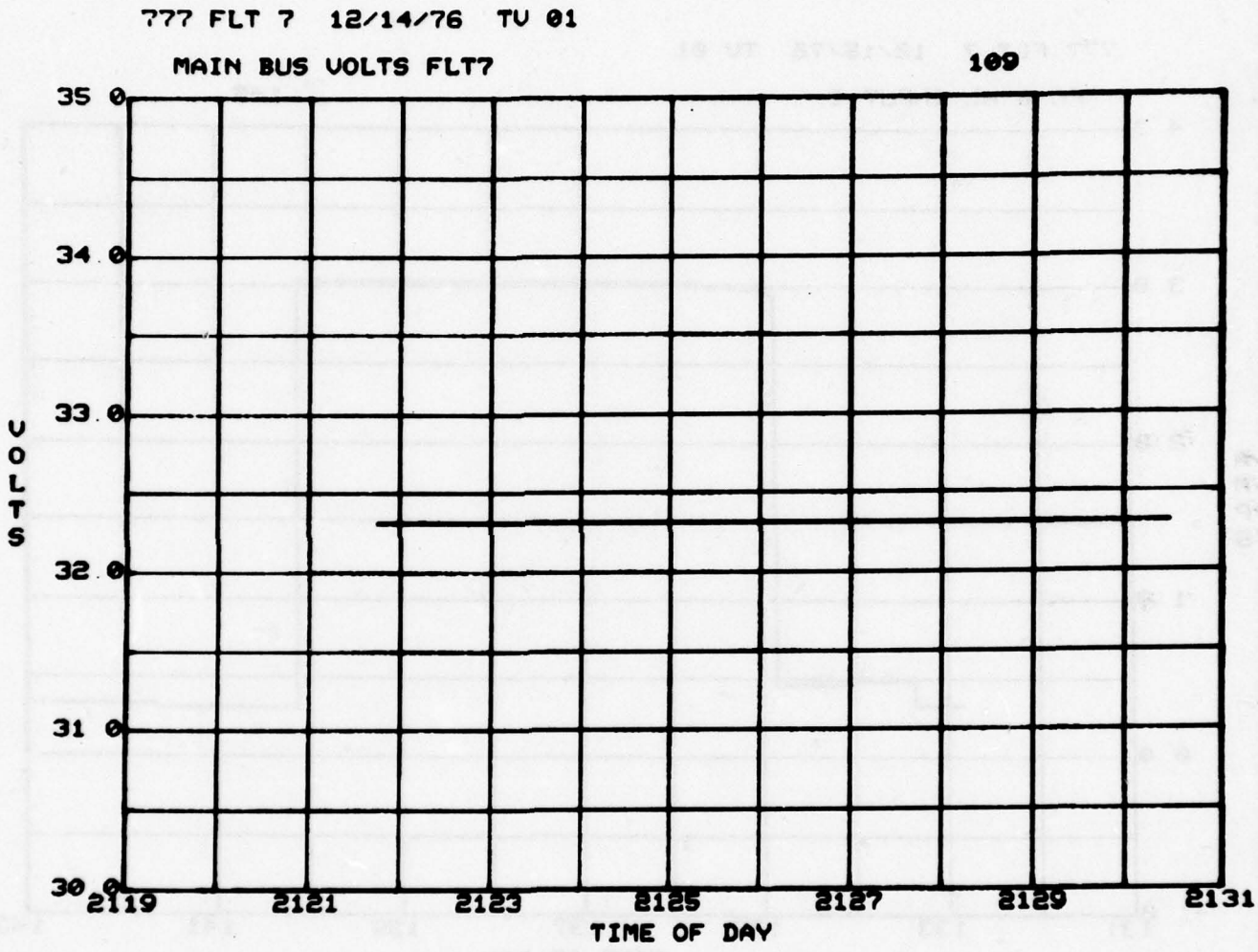
TIME OF DAY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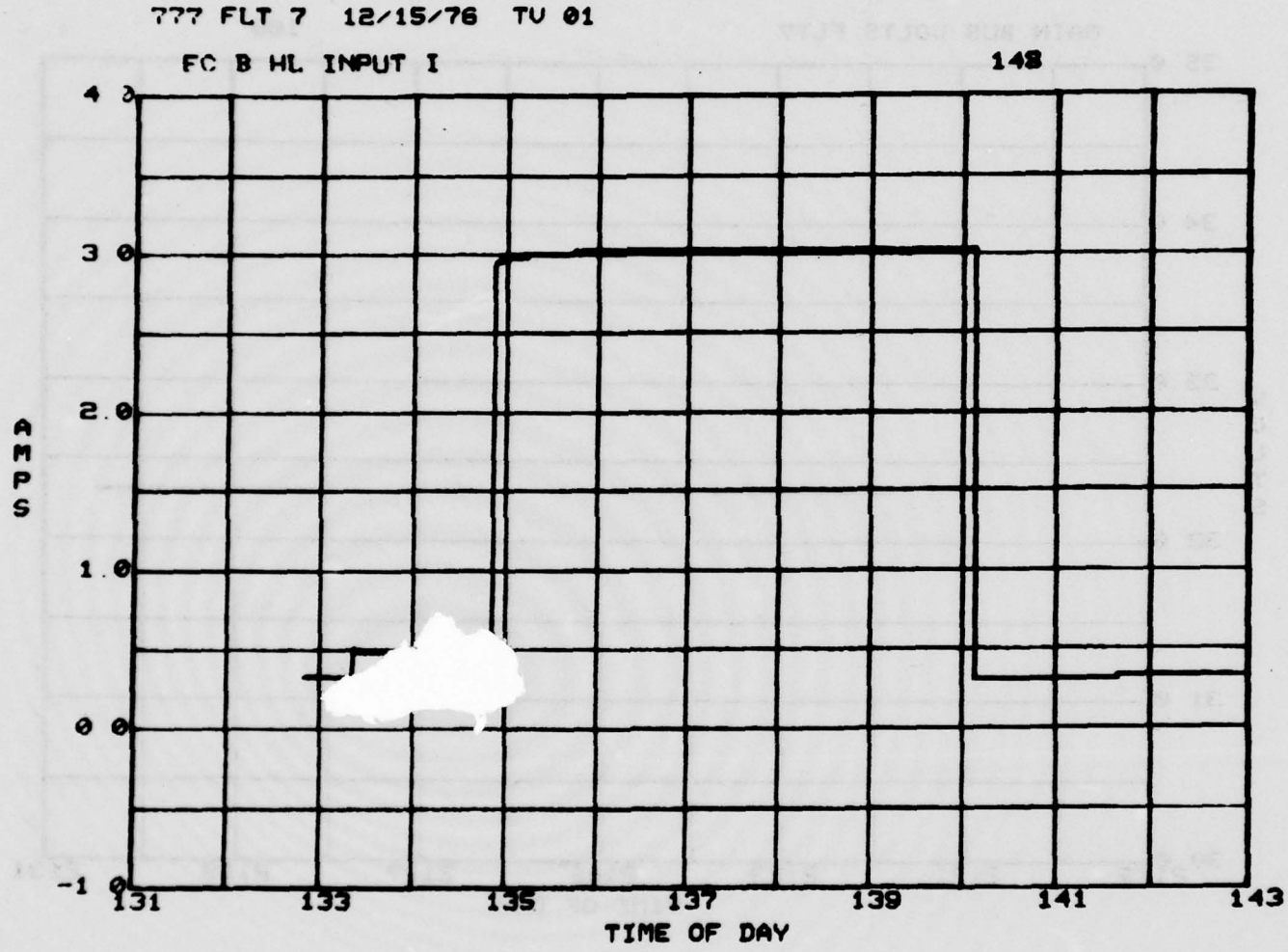
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AMPS
131
133
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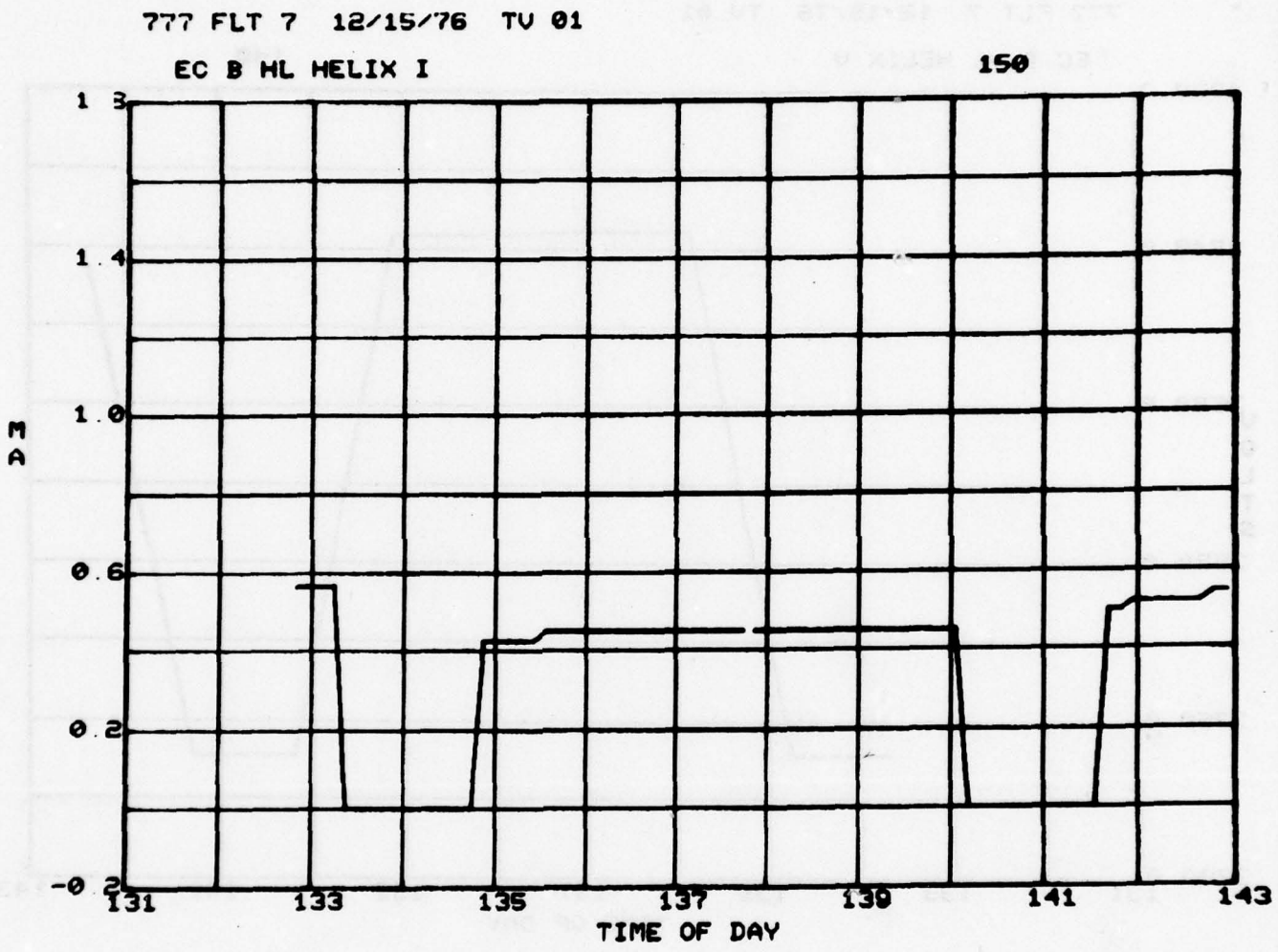
TIME OF DAY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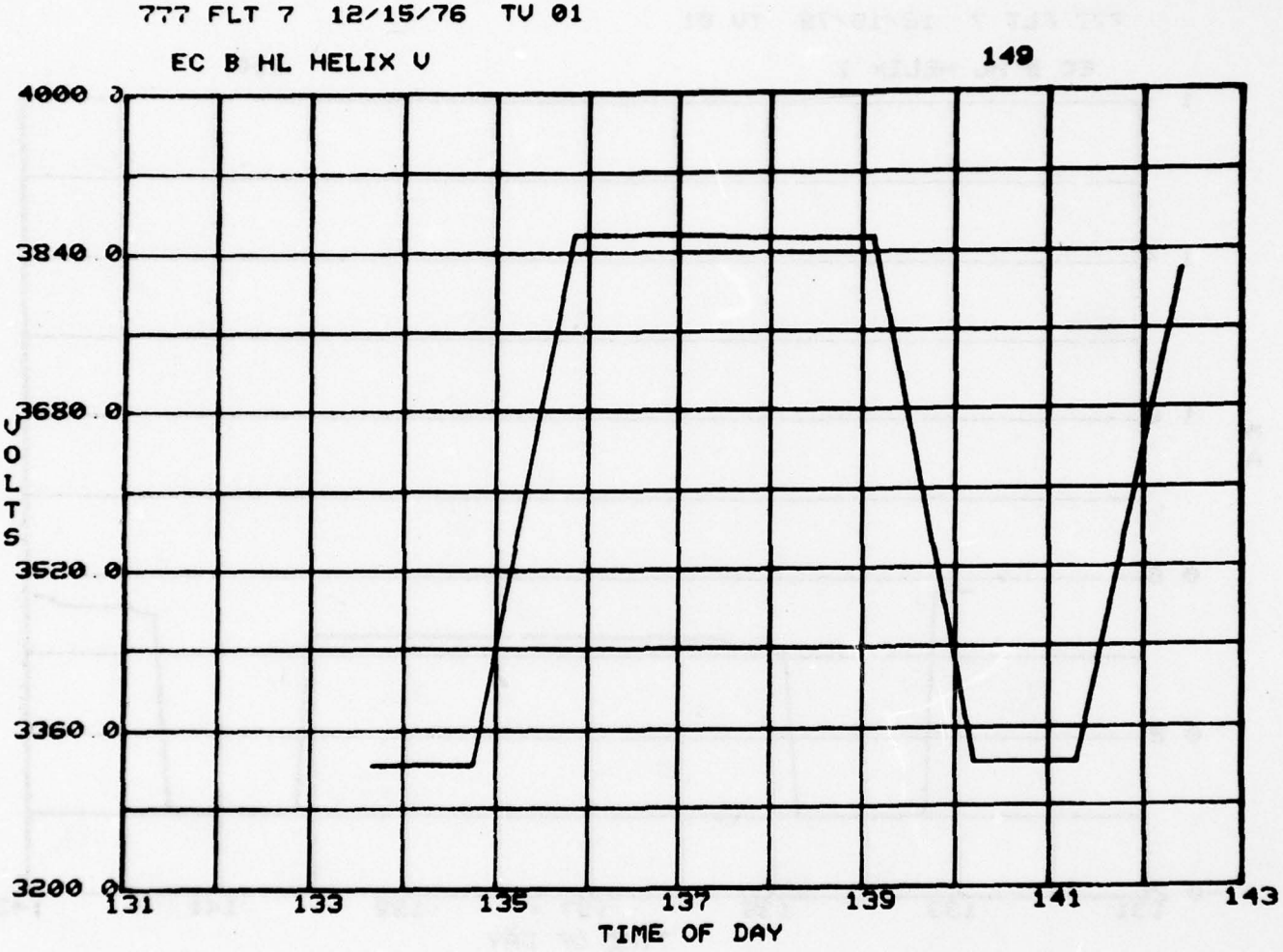
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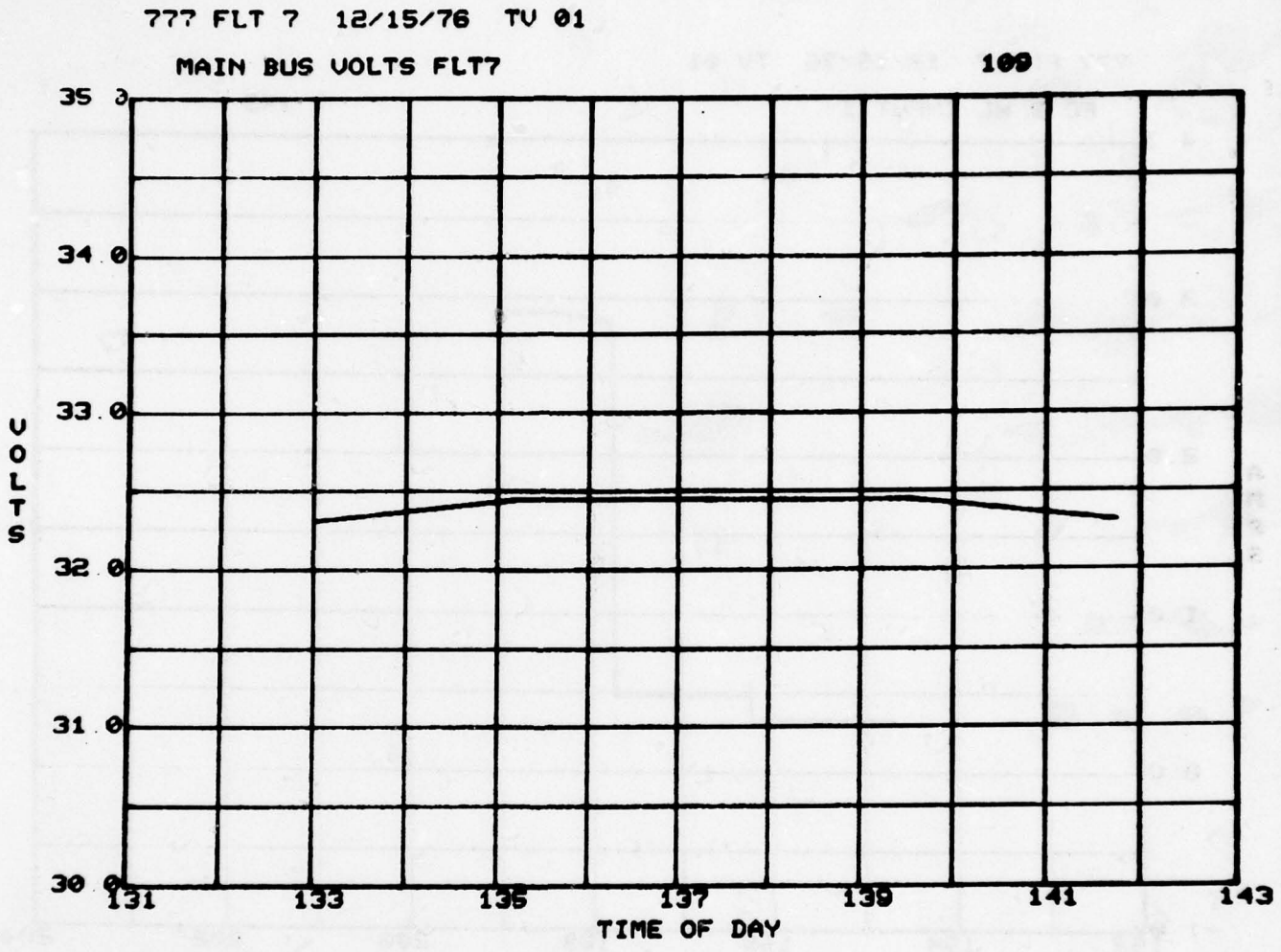
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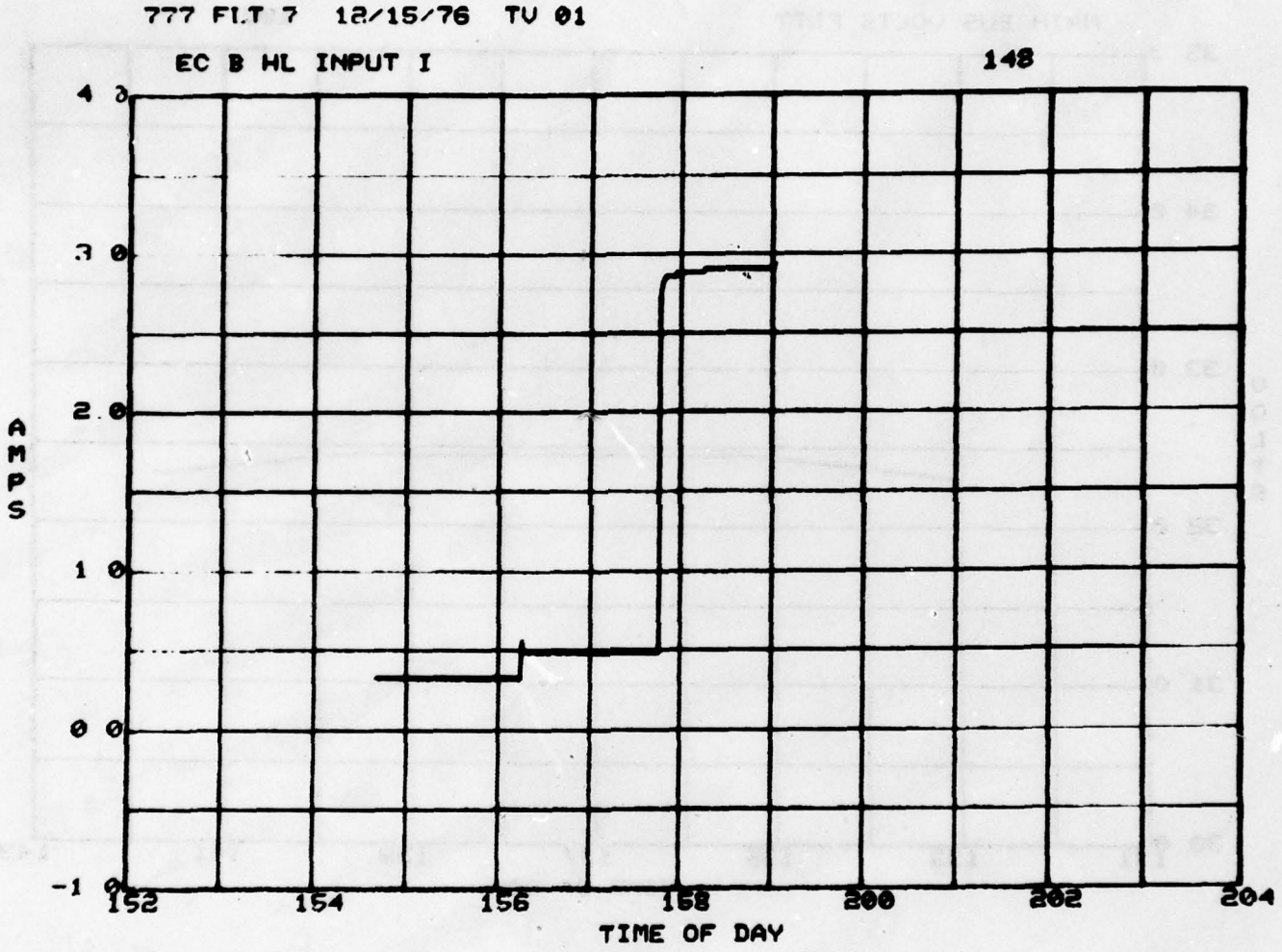
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AMPS
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202
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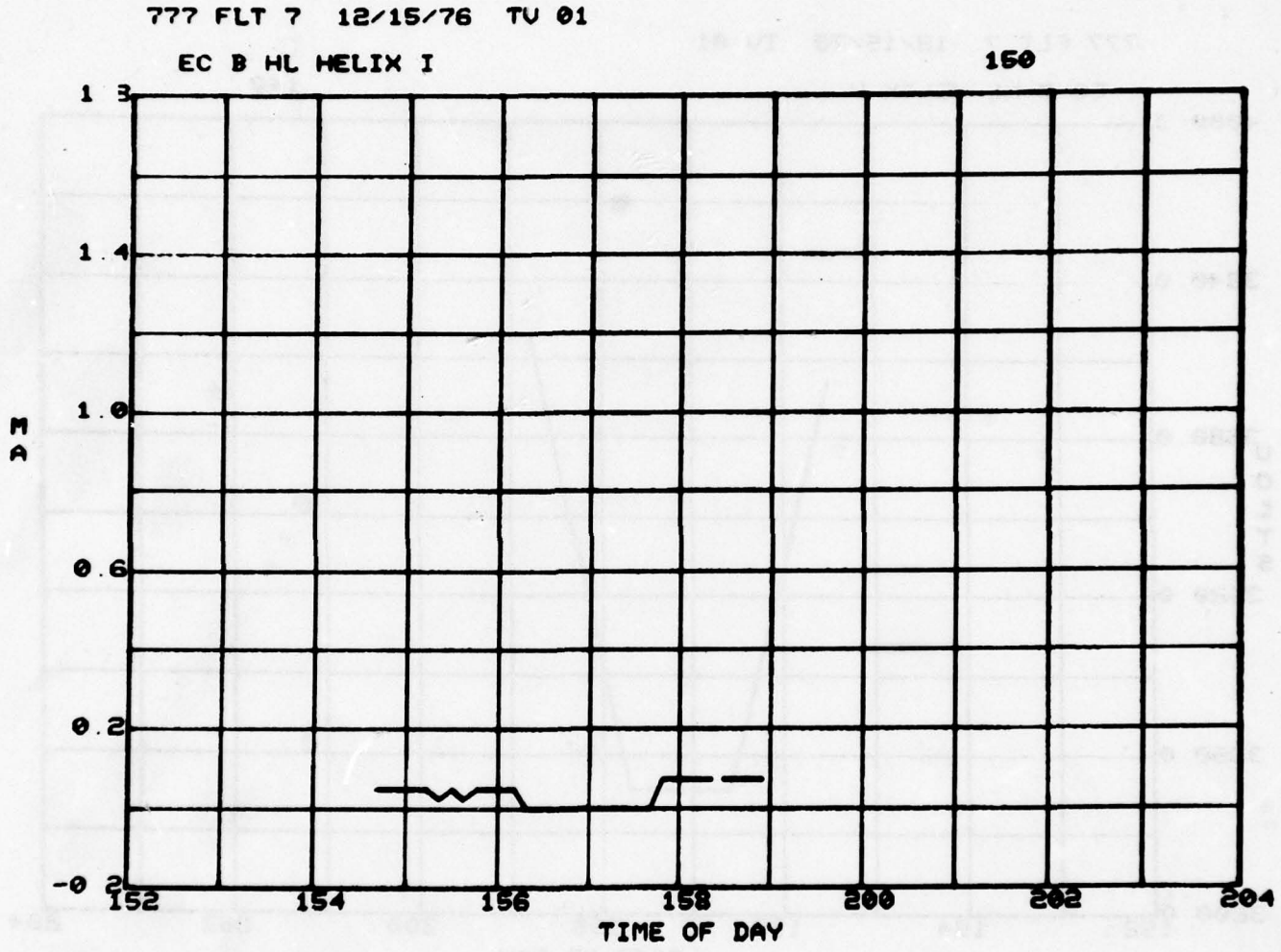
TIME OF DAY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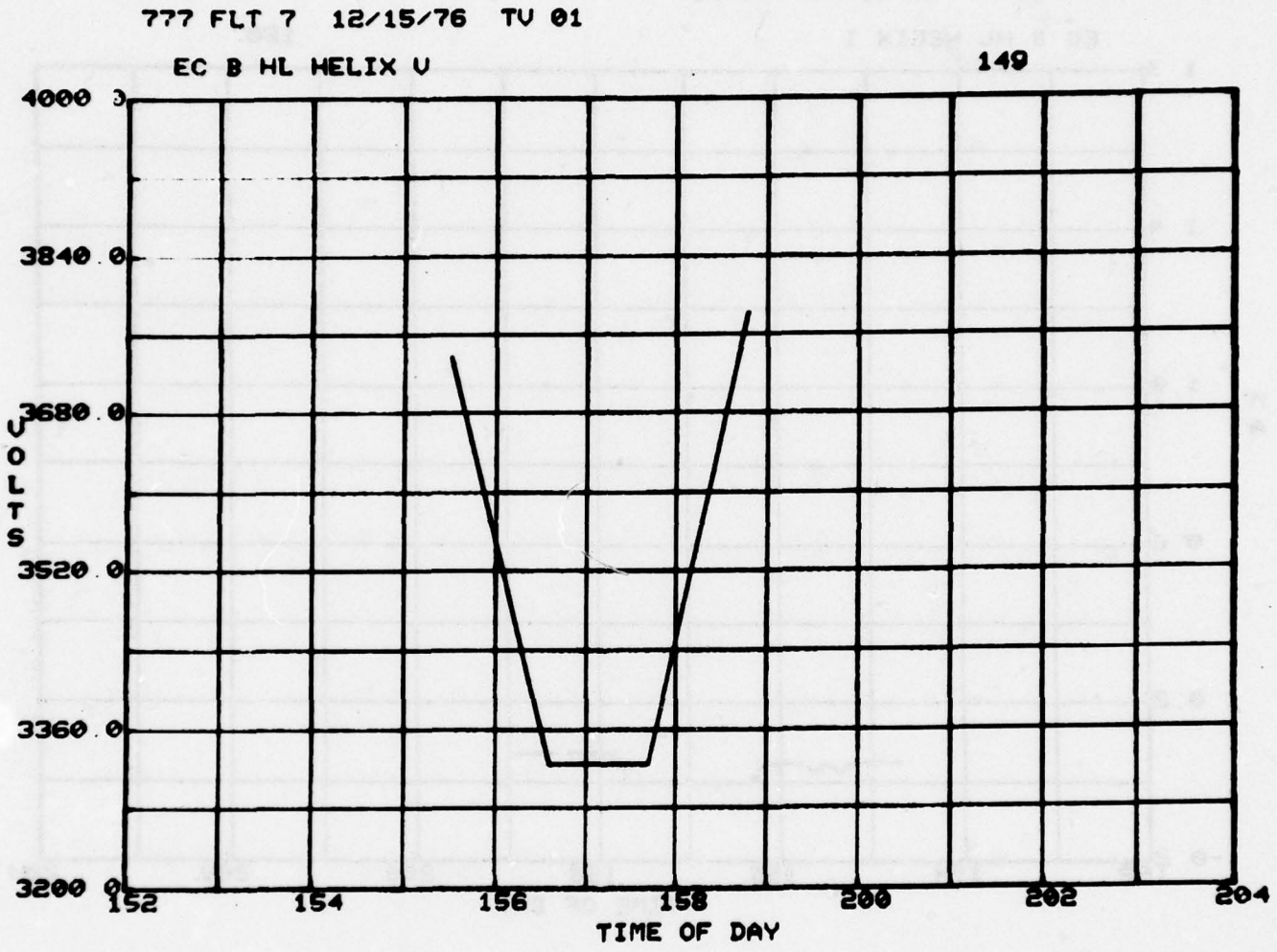
TIME OF DAY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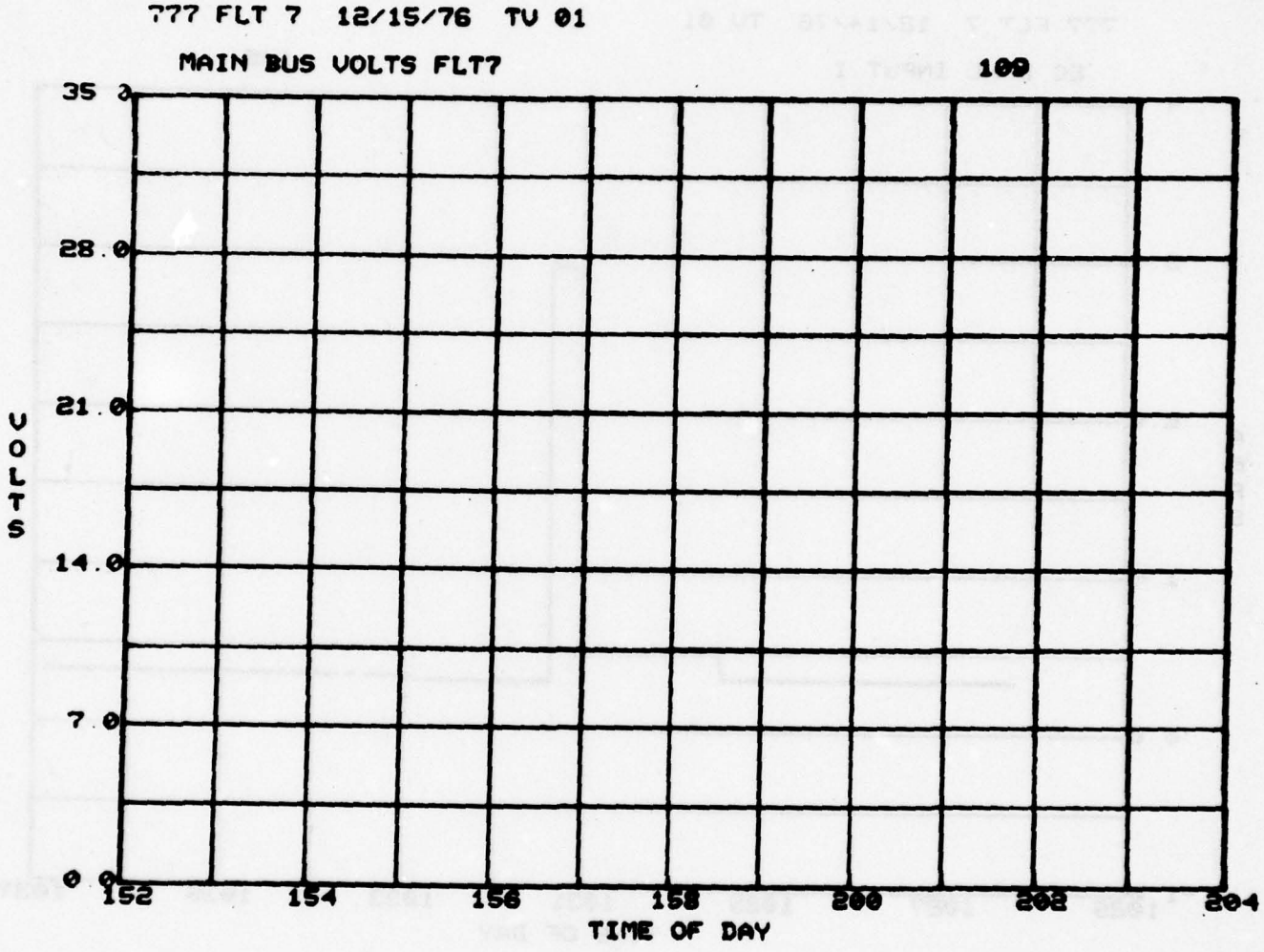
TIME OF DAY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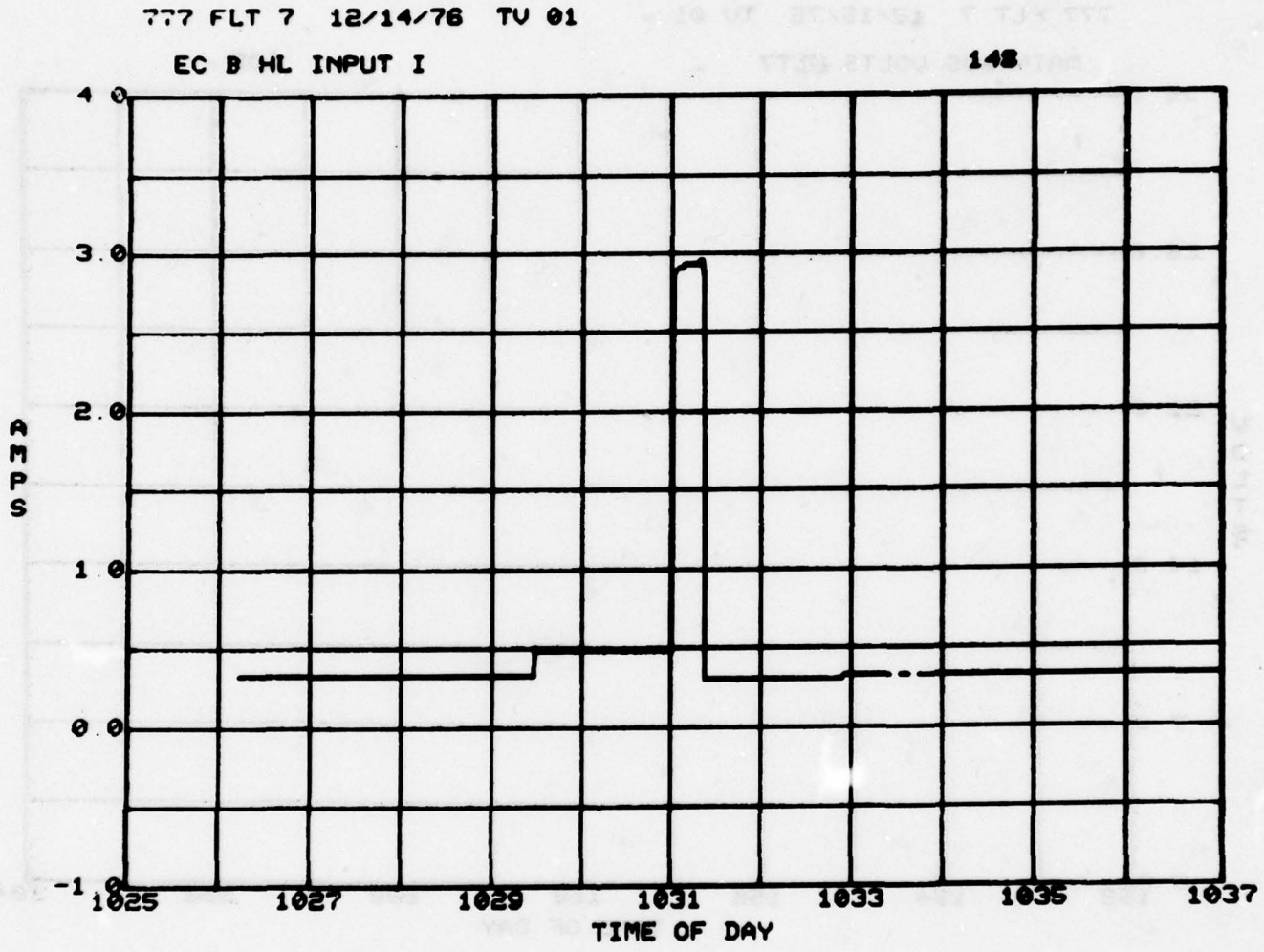
204
TIME OF DAY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EC B HL INPUT I
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4.0
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AMPS
1025
1027
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1035
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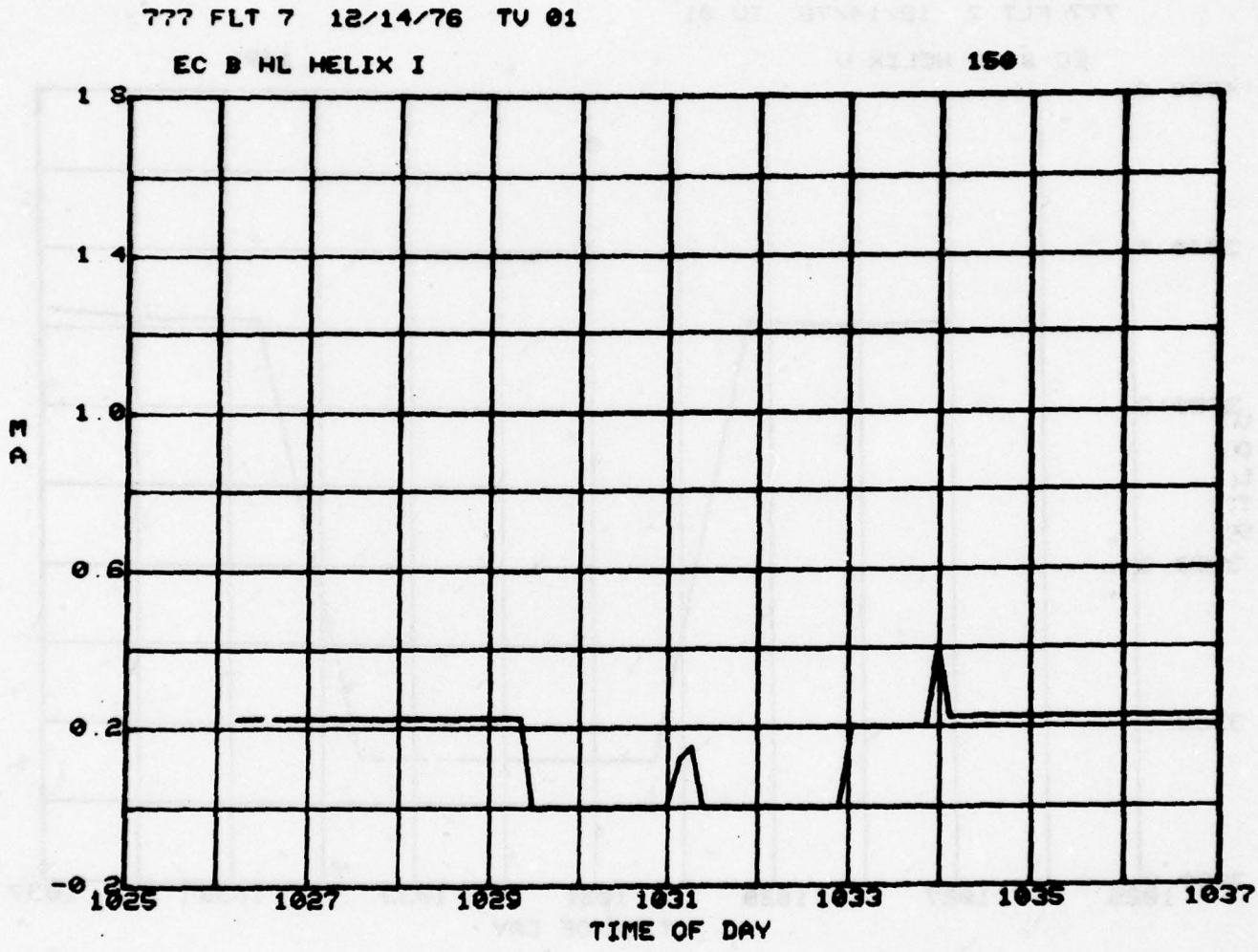
TIME OF DAY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-0.2
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1025
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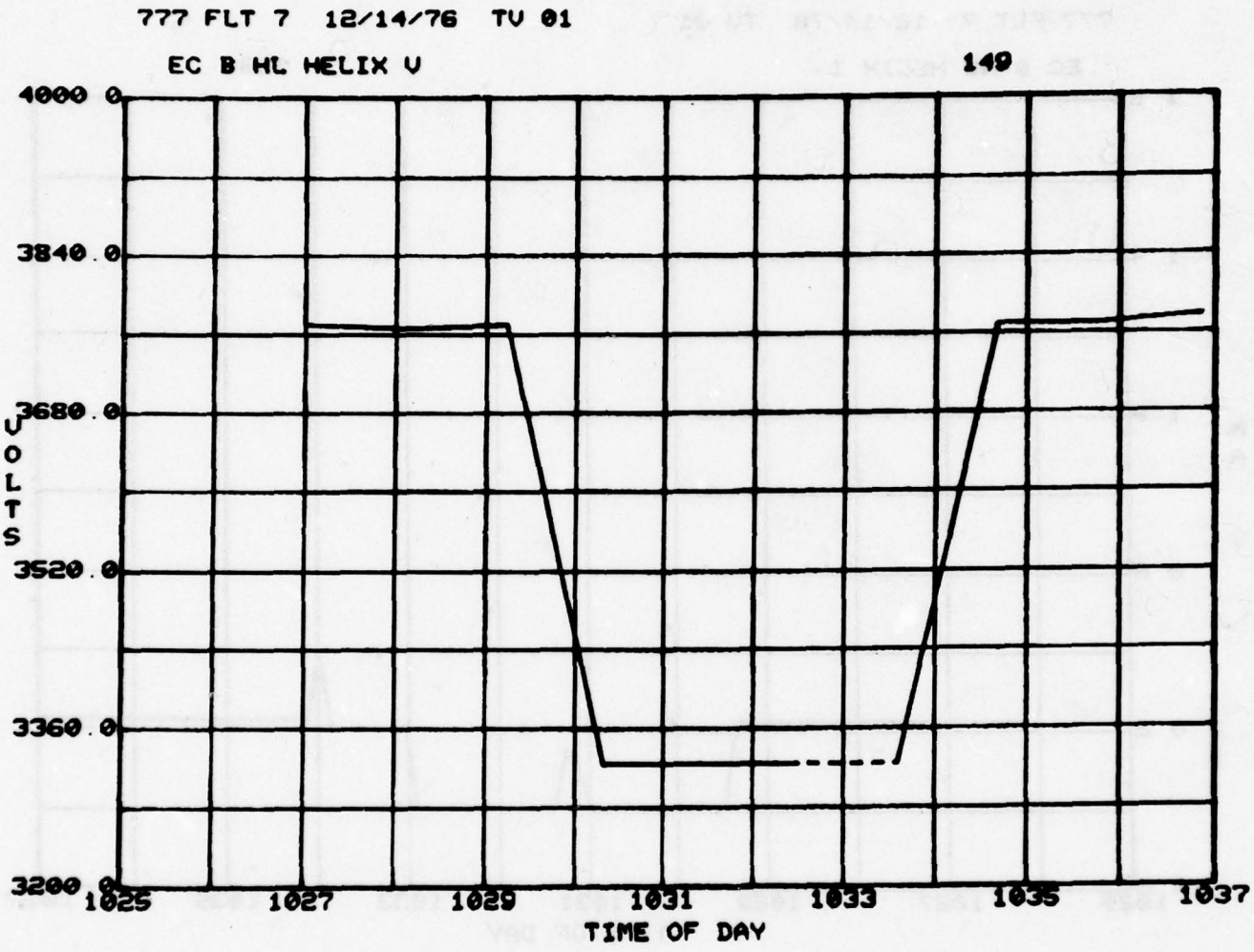
1037
TIME OF DAY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4000.0
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VOLTS
1025
1027
1029
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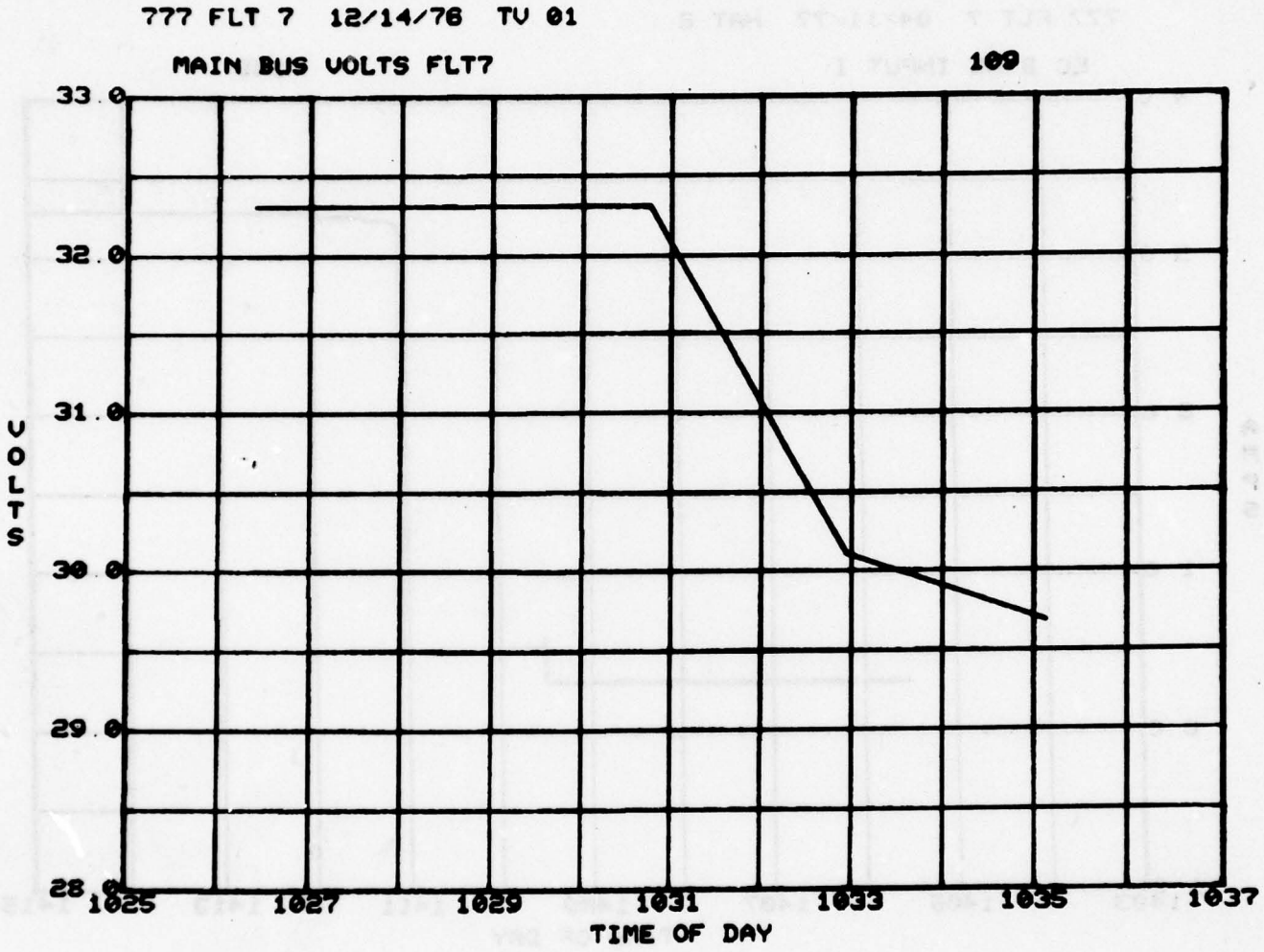
1035
1037
TIME OF DAY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MAIN BUS VOLTS FLT7
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33.0
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31.0
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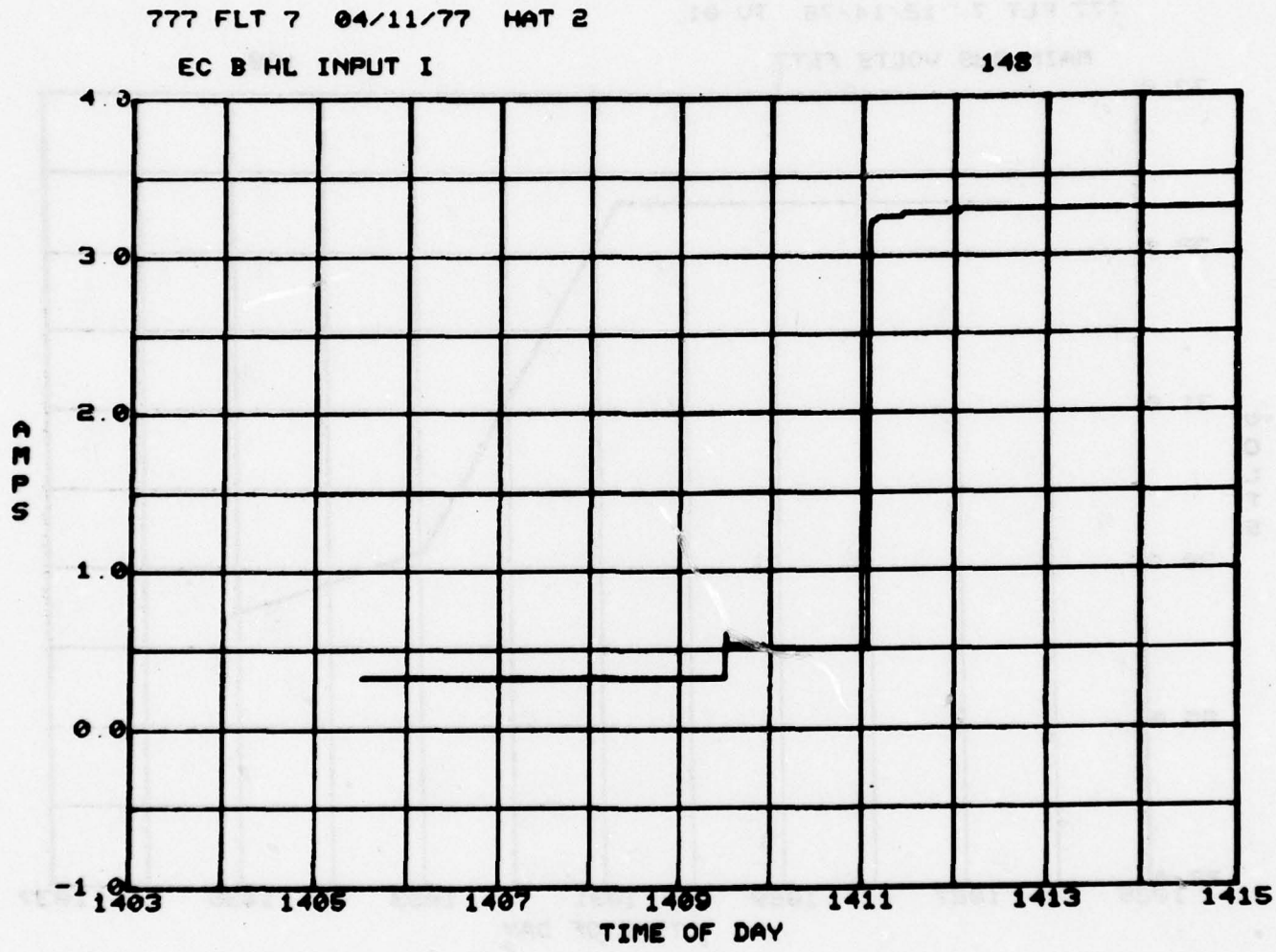
29.0
28.0
VOLTS
1025
1027
1029
1031
1033
1035
1037
TIME OF DAY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EC B HL INPUT I
148
4.0
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2.0
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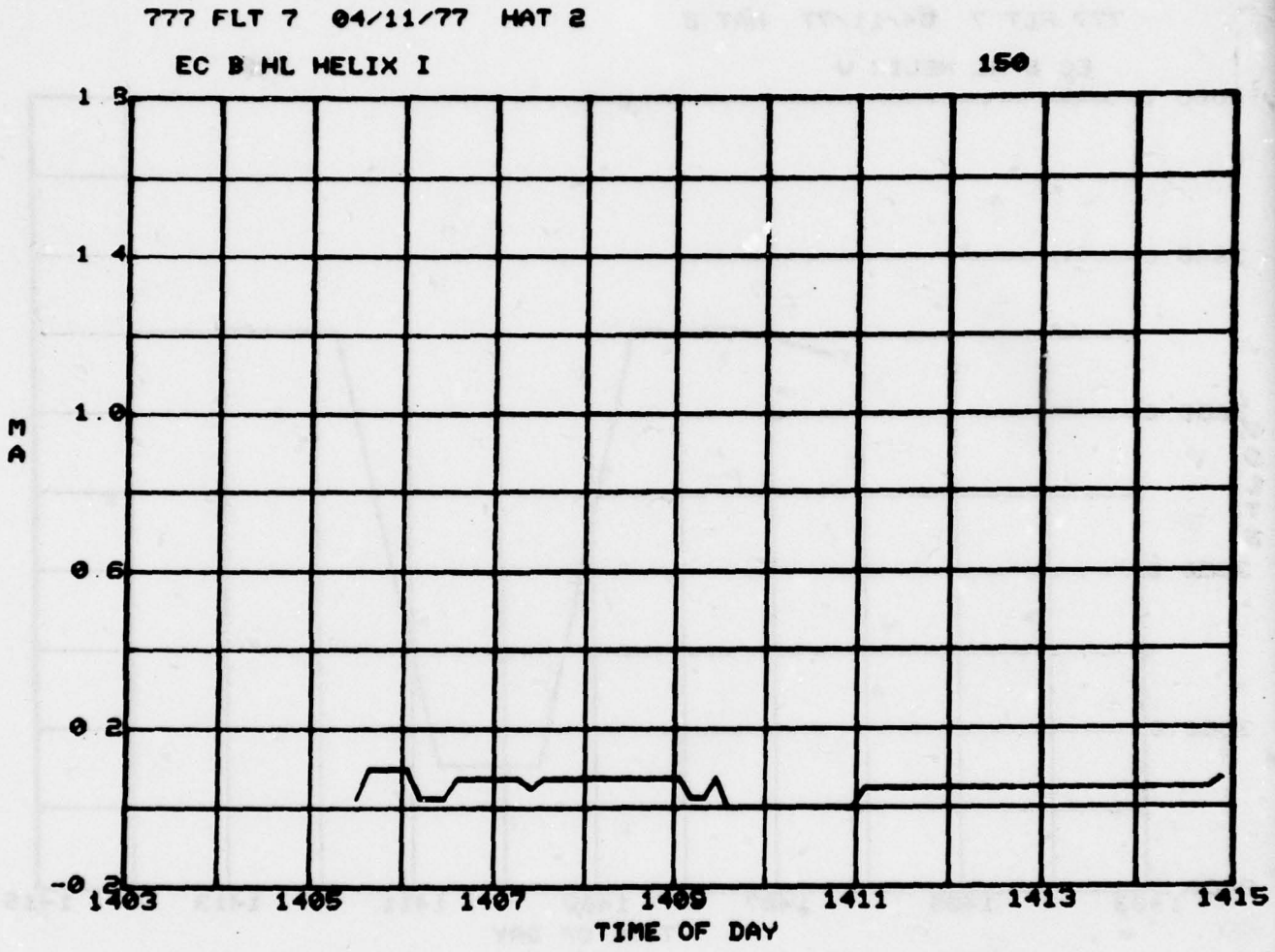
0.0
-1.0
AMPS
1403
1405
1407
1409
1411
1413
1415
TIME OF DAY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150
1.8
1.4
1.0
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-0.2
MA
1403
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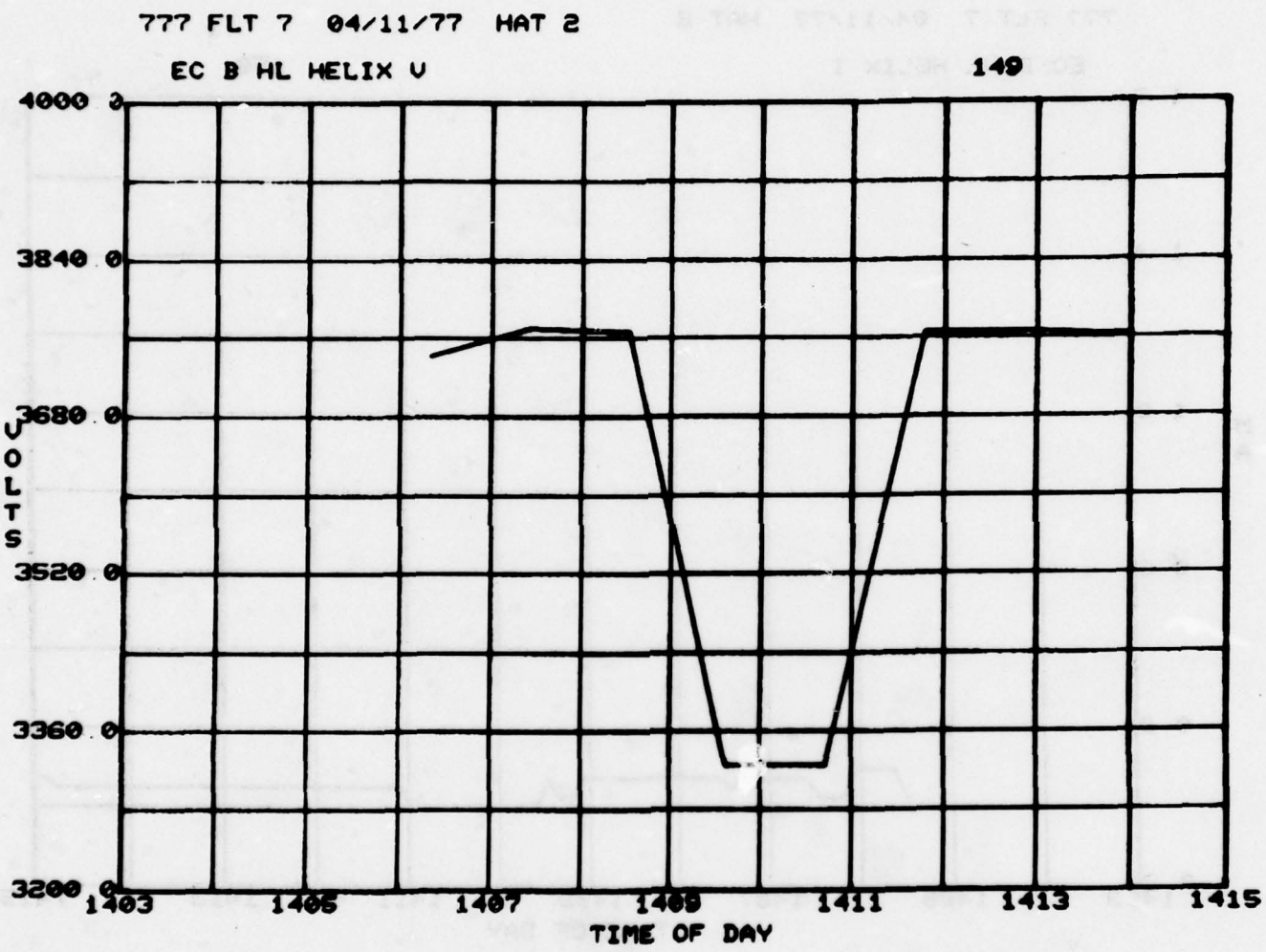
1407
1409
1411
1413
1415
TIME OF DAY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VOLTS
1403
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1409
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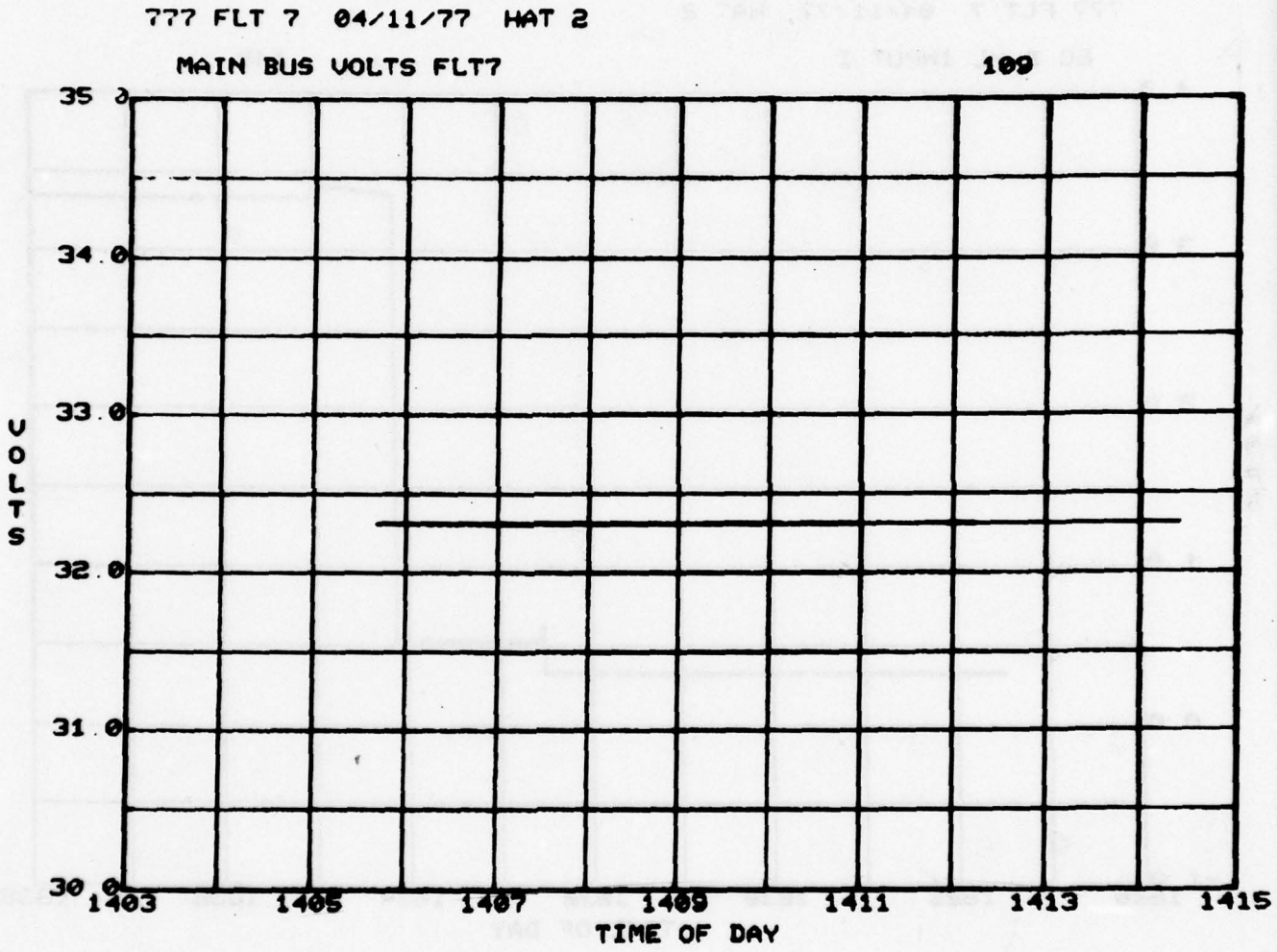
1413
1415
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
MAIN BUS VOLTS FLT7
109
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VOLTS
1403
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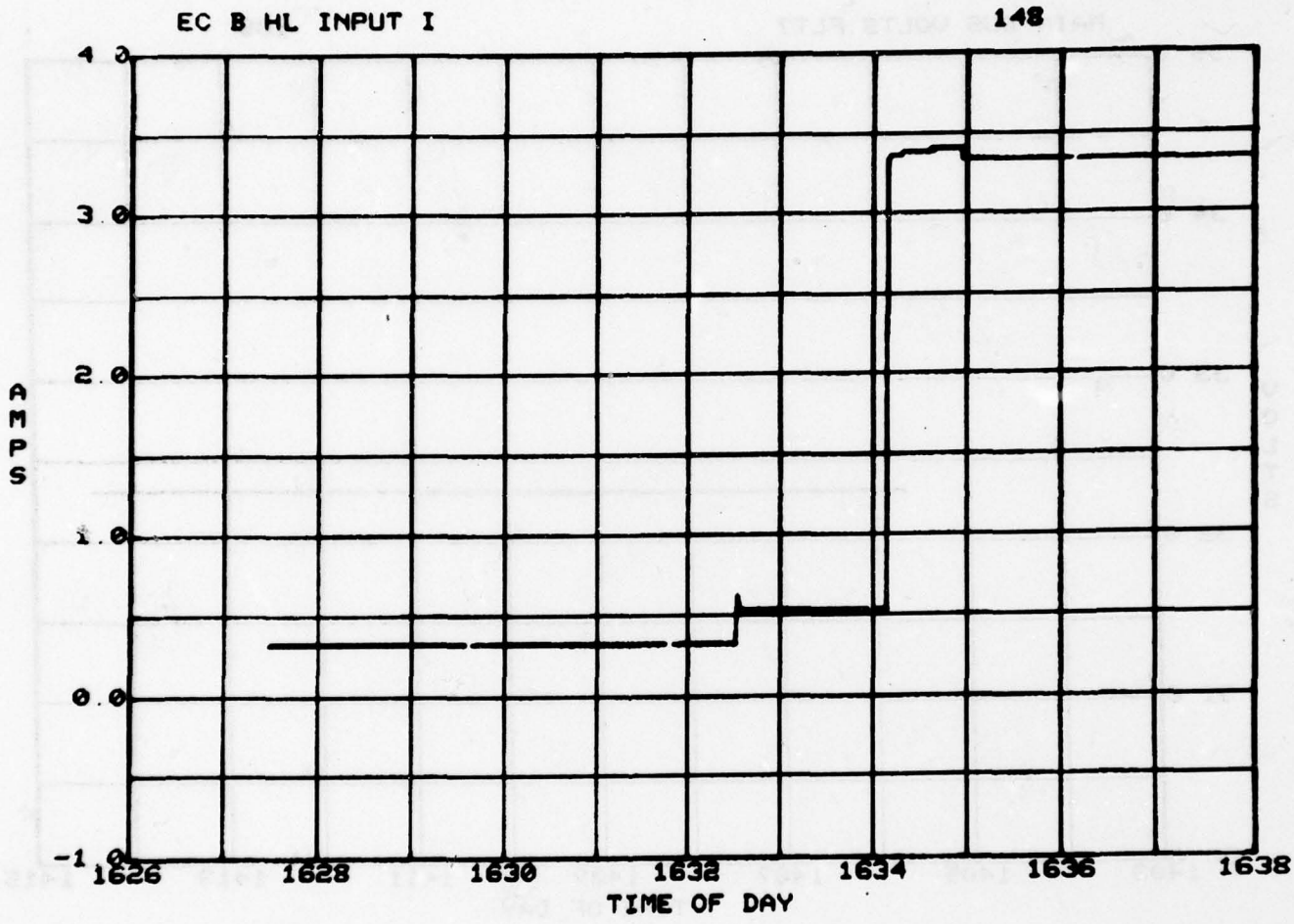
TIME OF DAY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EC B HL INPUT I
148
4.0
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-1.0
AMPS
1626
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1636
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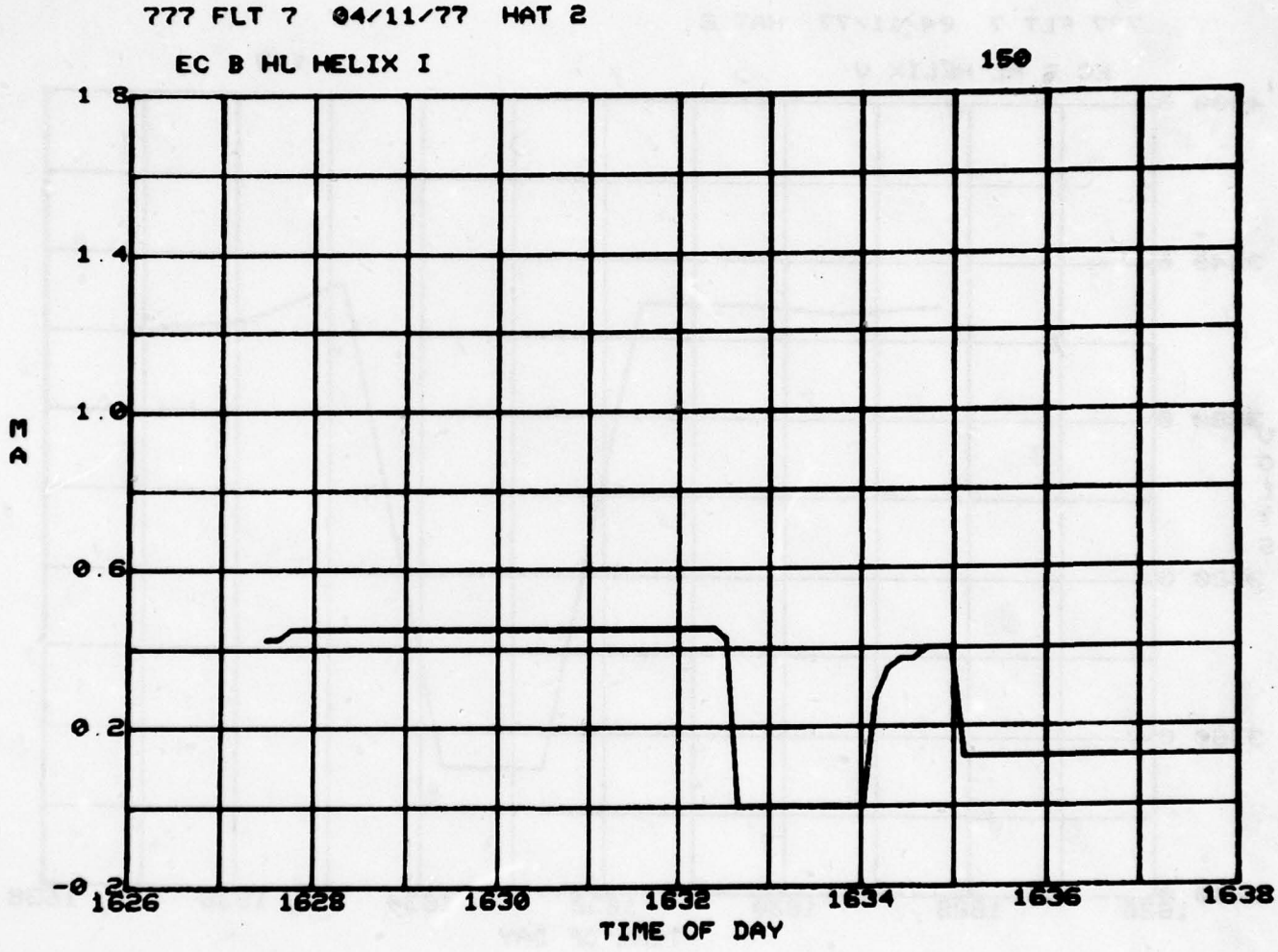
TIME OF DAY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1.8
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0.2
-0.2
MA
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1636
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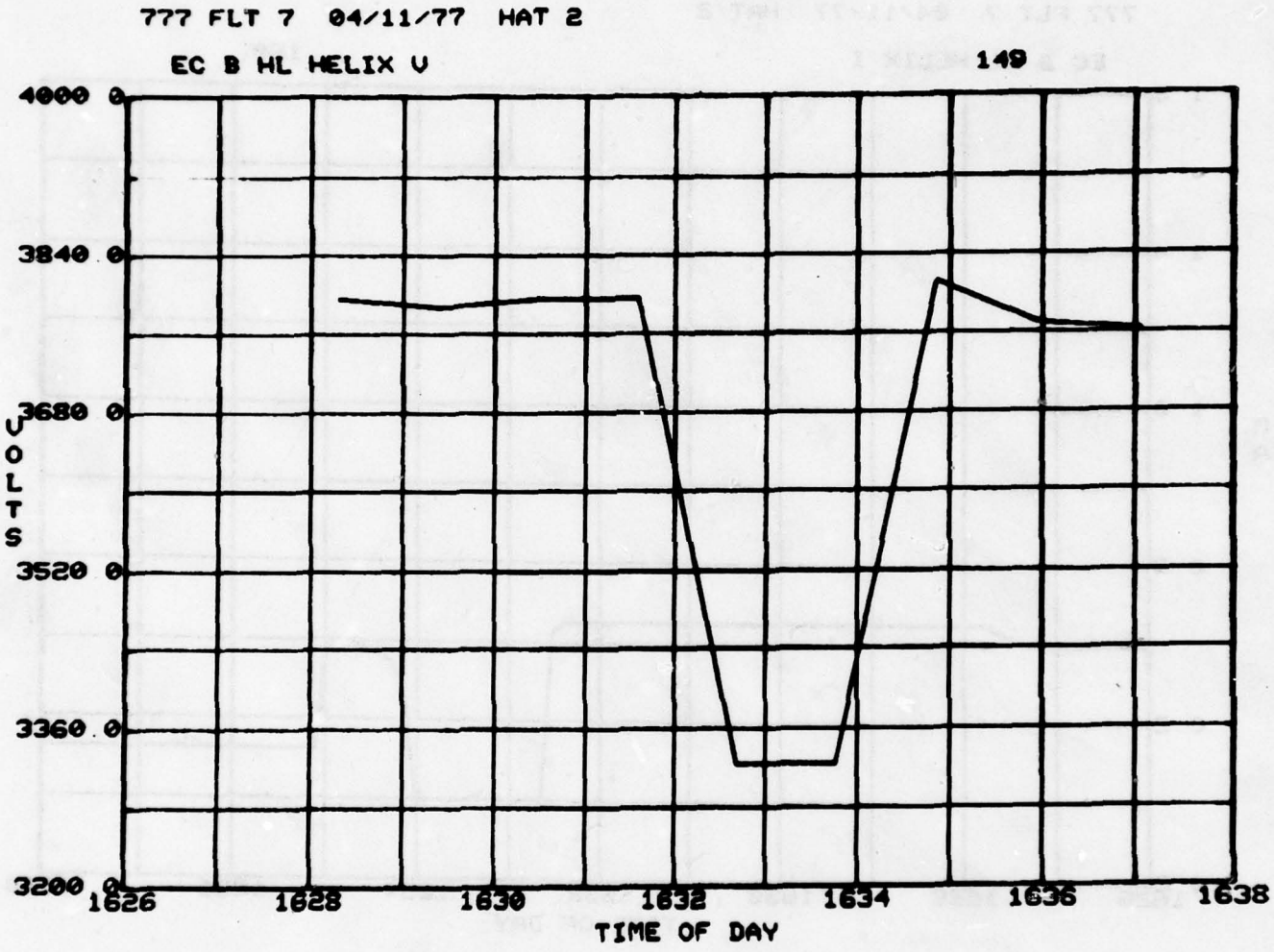
TIME OF DAY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EC B HL HELIX V
149
4000 0
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VOLTS
1626
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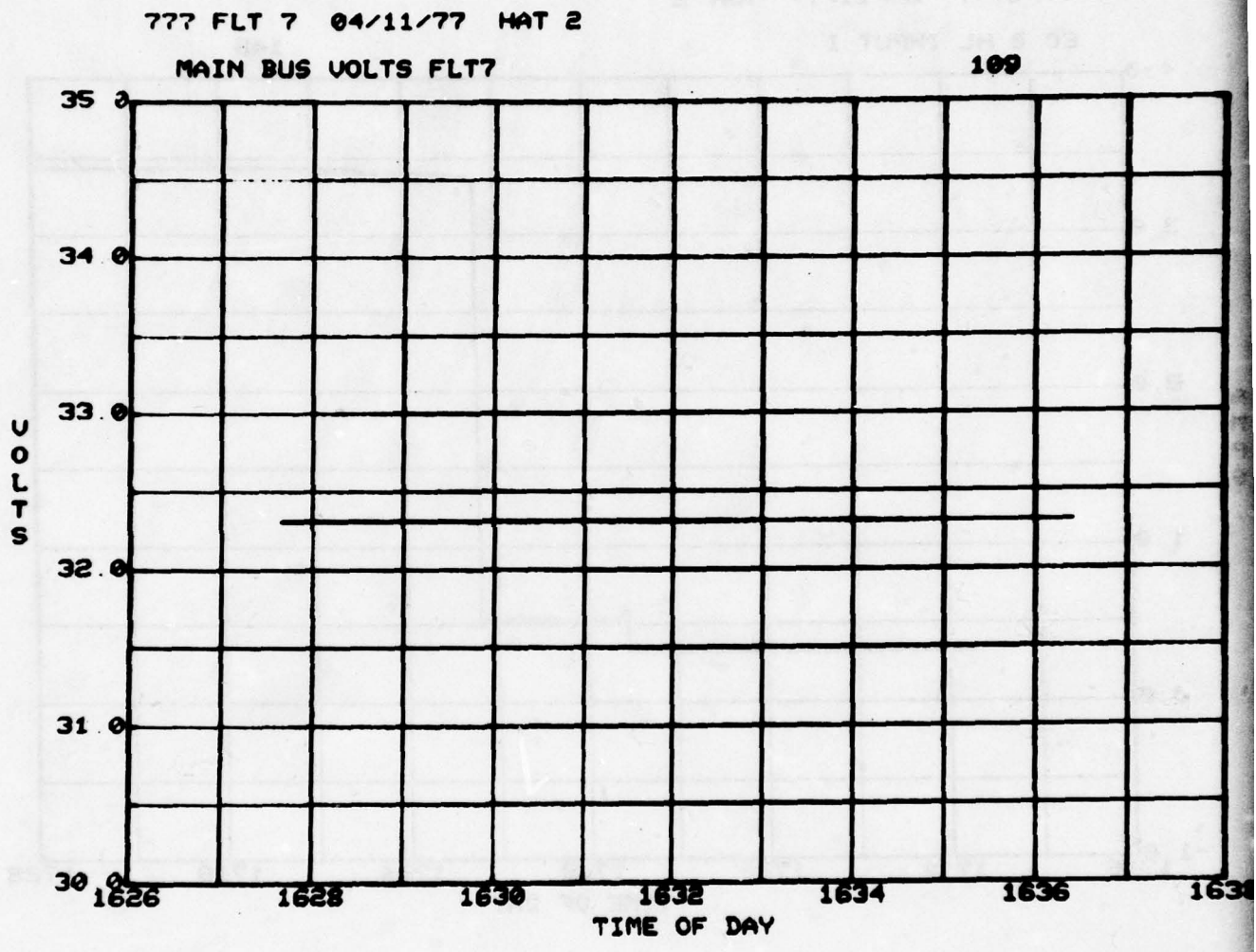
TIME OF DAY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MAIN BUS VOLTS FLT7
109
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VOLTS
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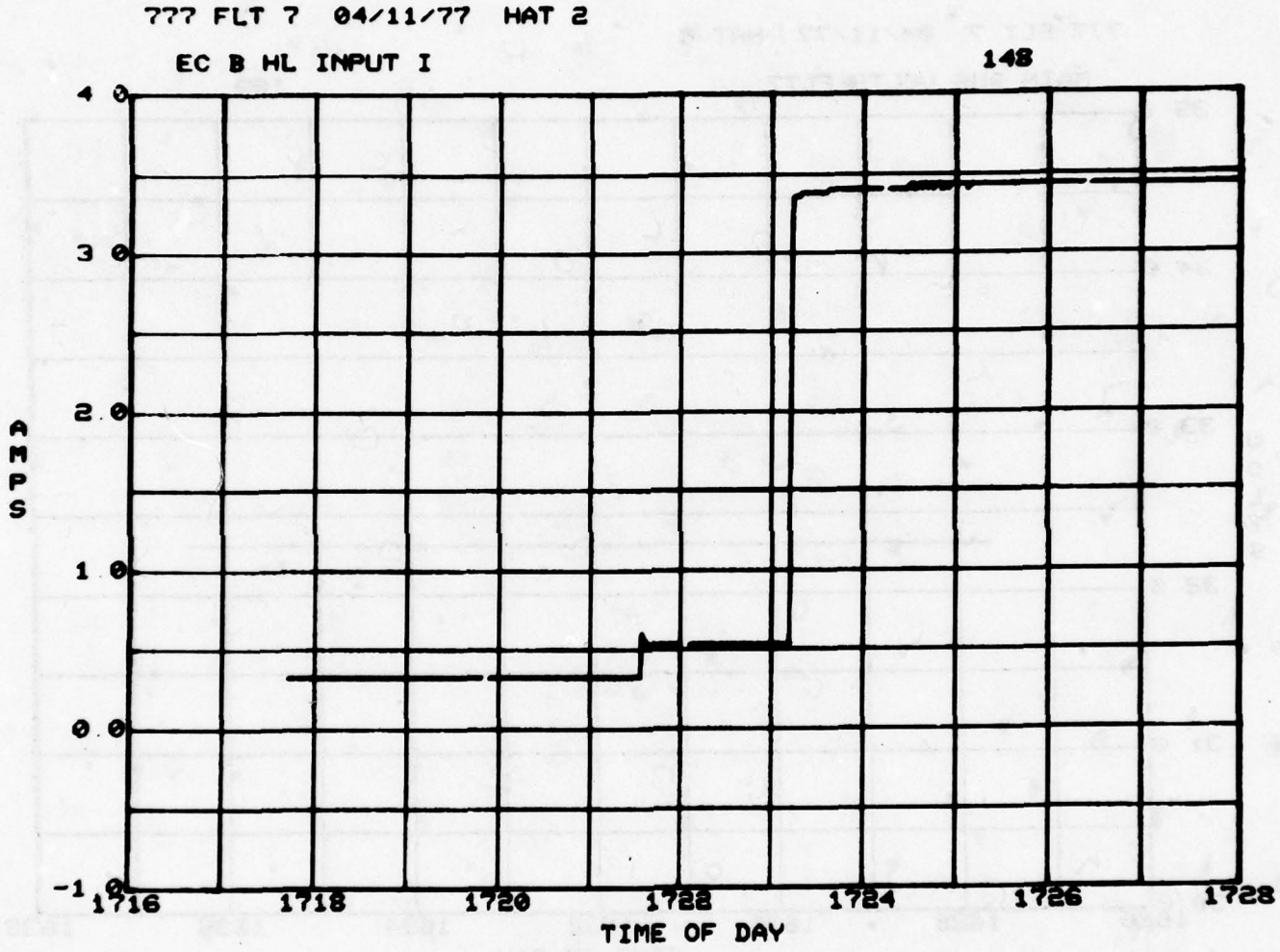
1634
1636
TIME OF DAY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EC B HL INPUT I
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AMPS
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1726
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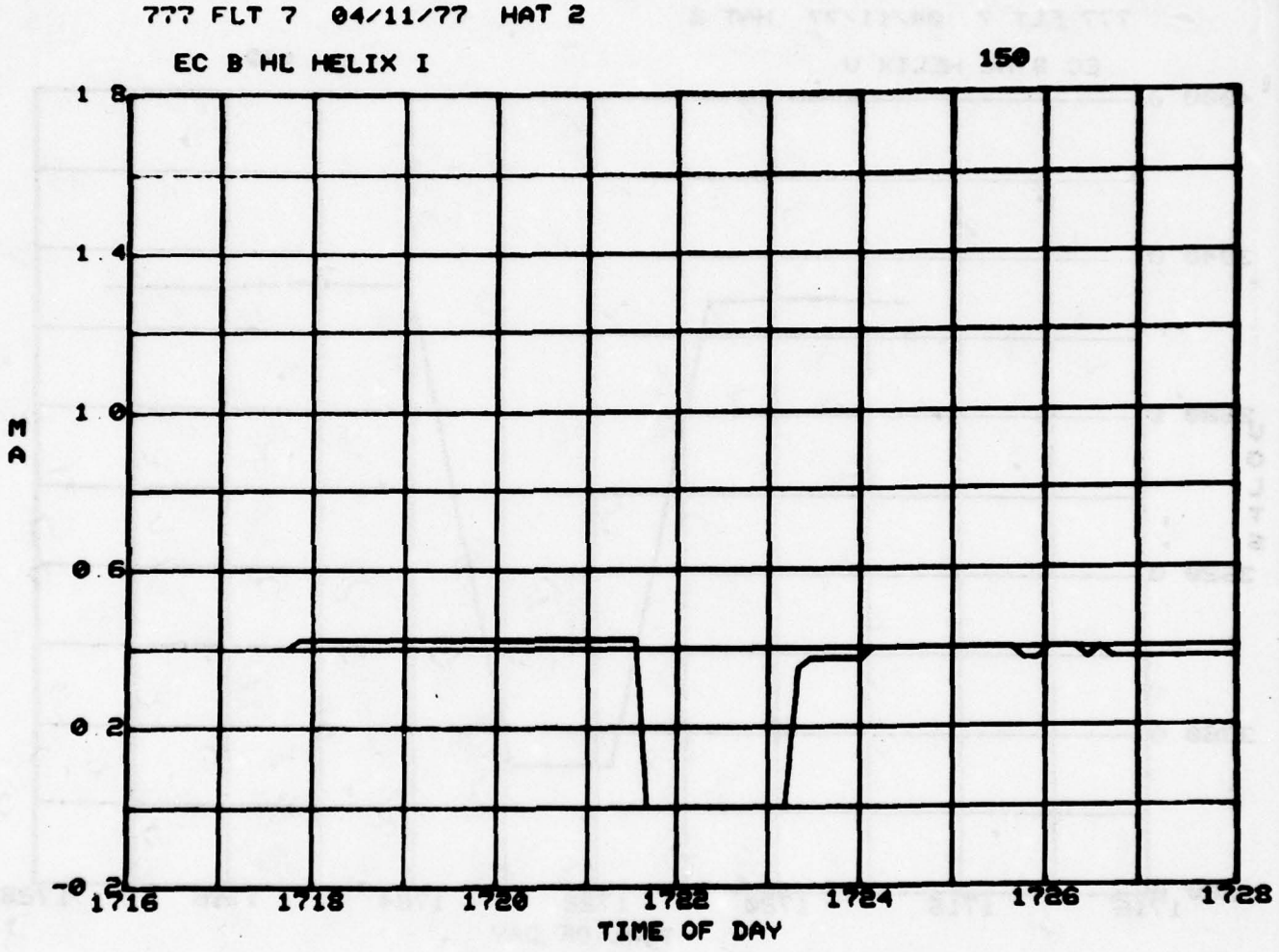
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
EC B HL HELIX I
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1.8
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1.0
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0.2
-0.2
MA
1716
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1720
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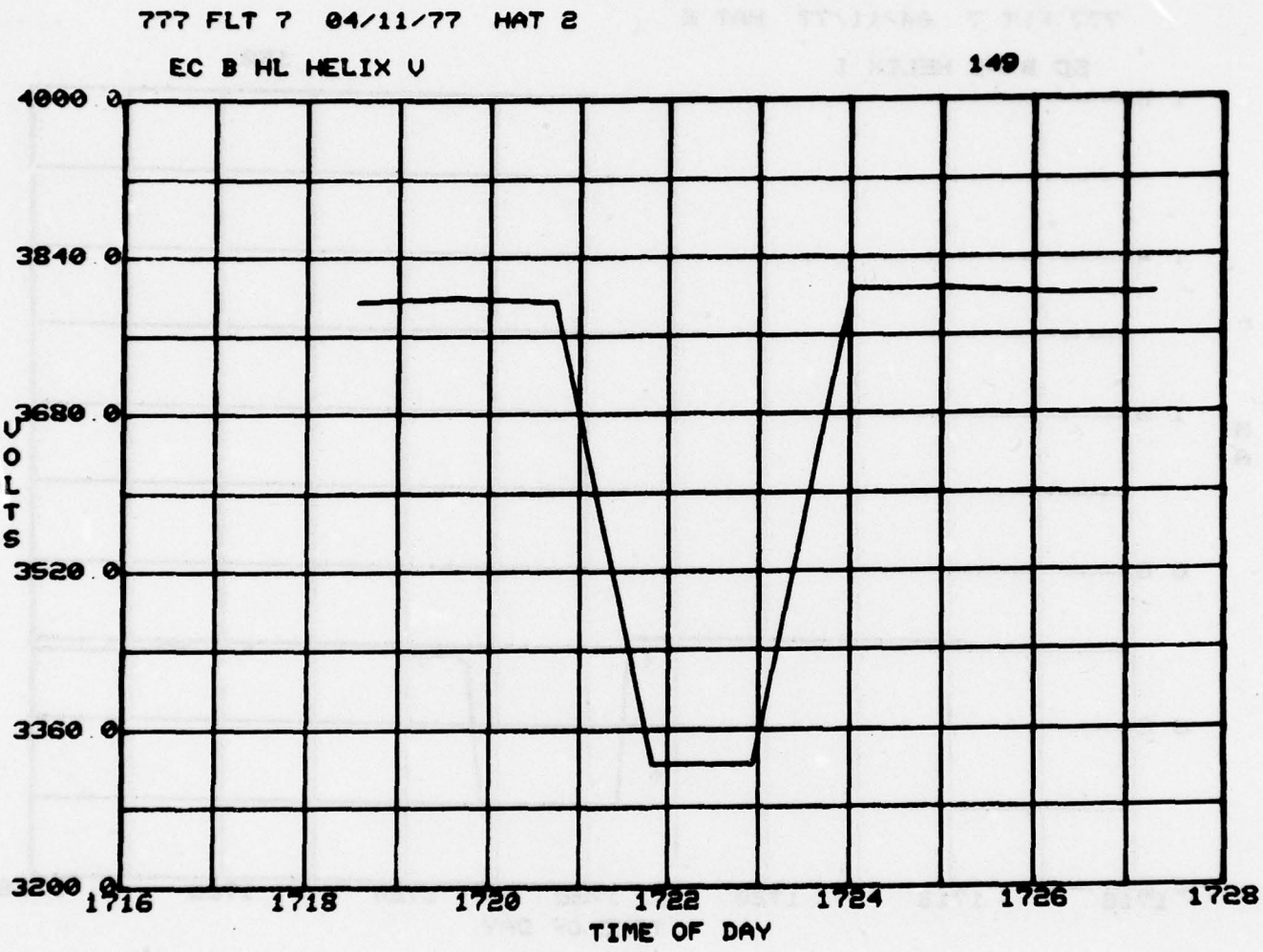
1724
1726
1728
TIME OF DAY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VOLTS
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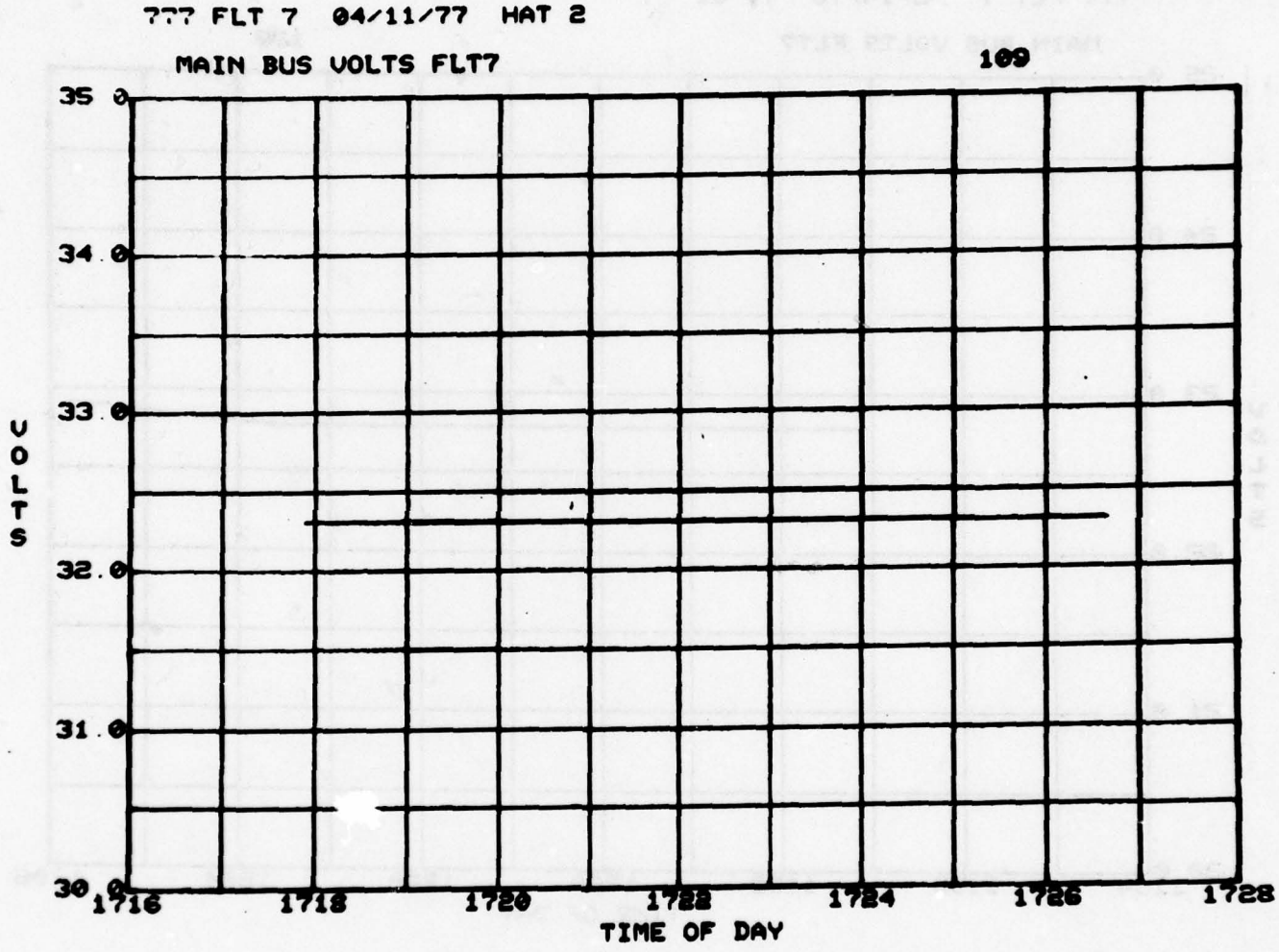
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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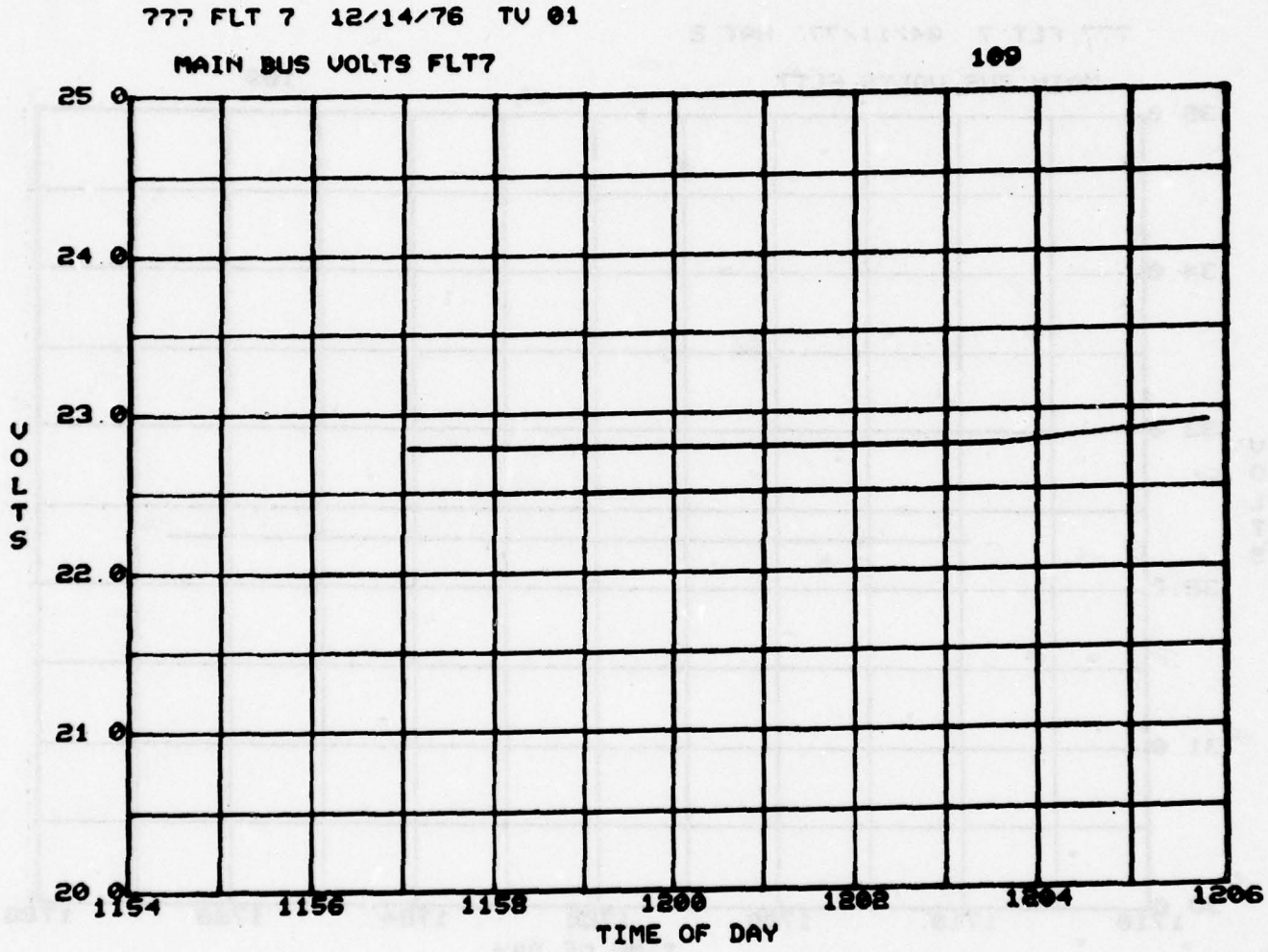
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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1158
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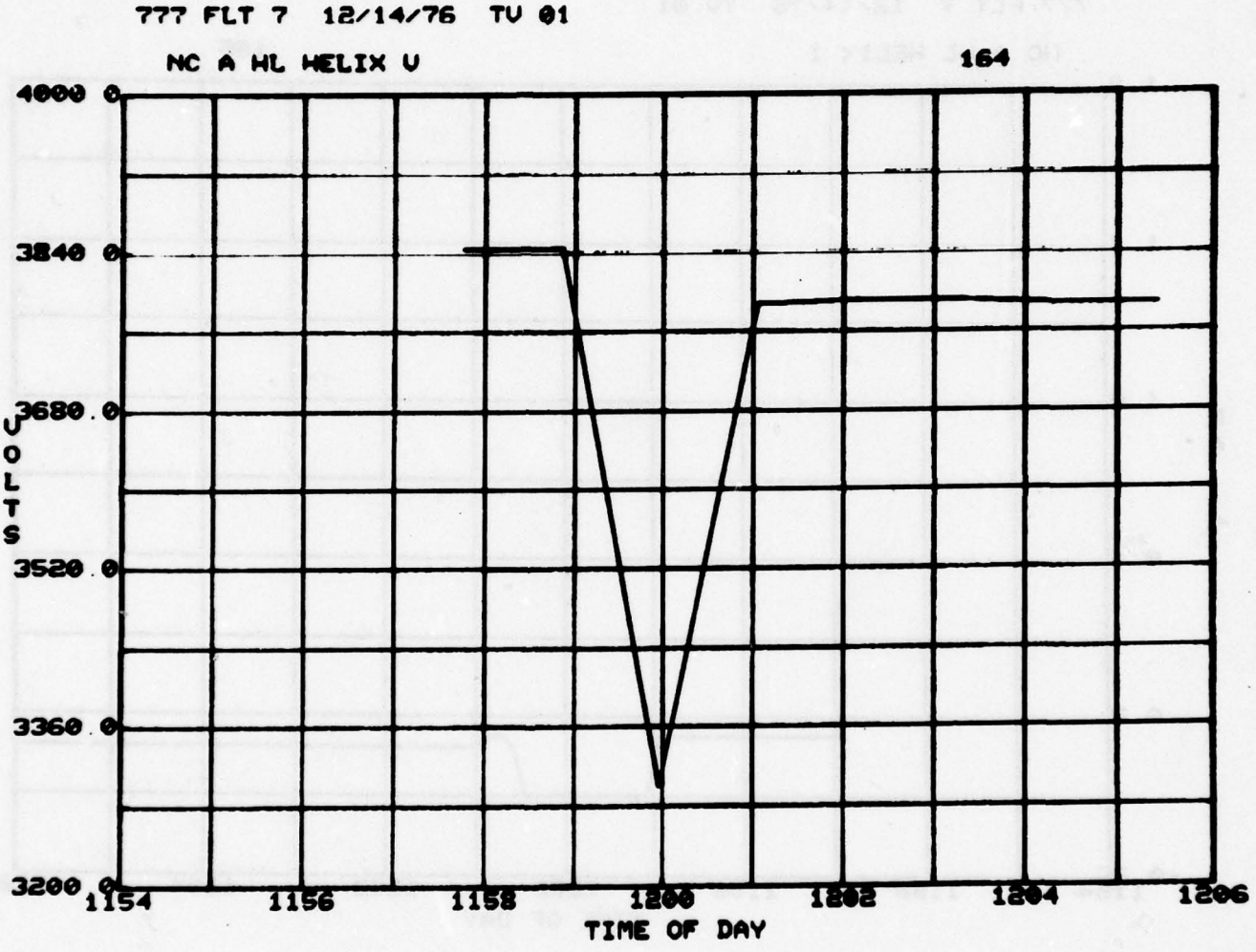
1206
TIME OF DAY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VOLTS
1154
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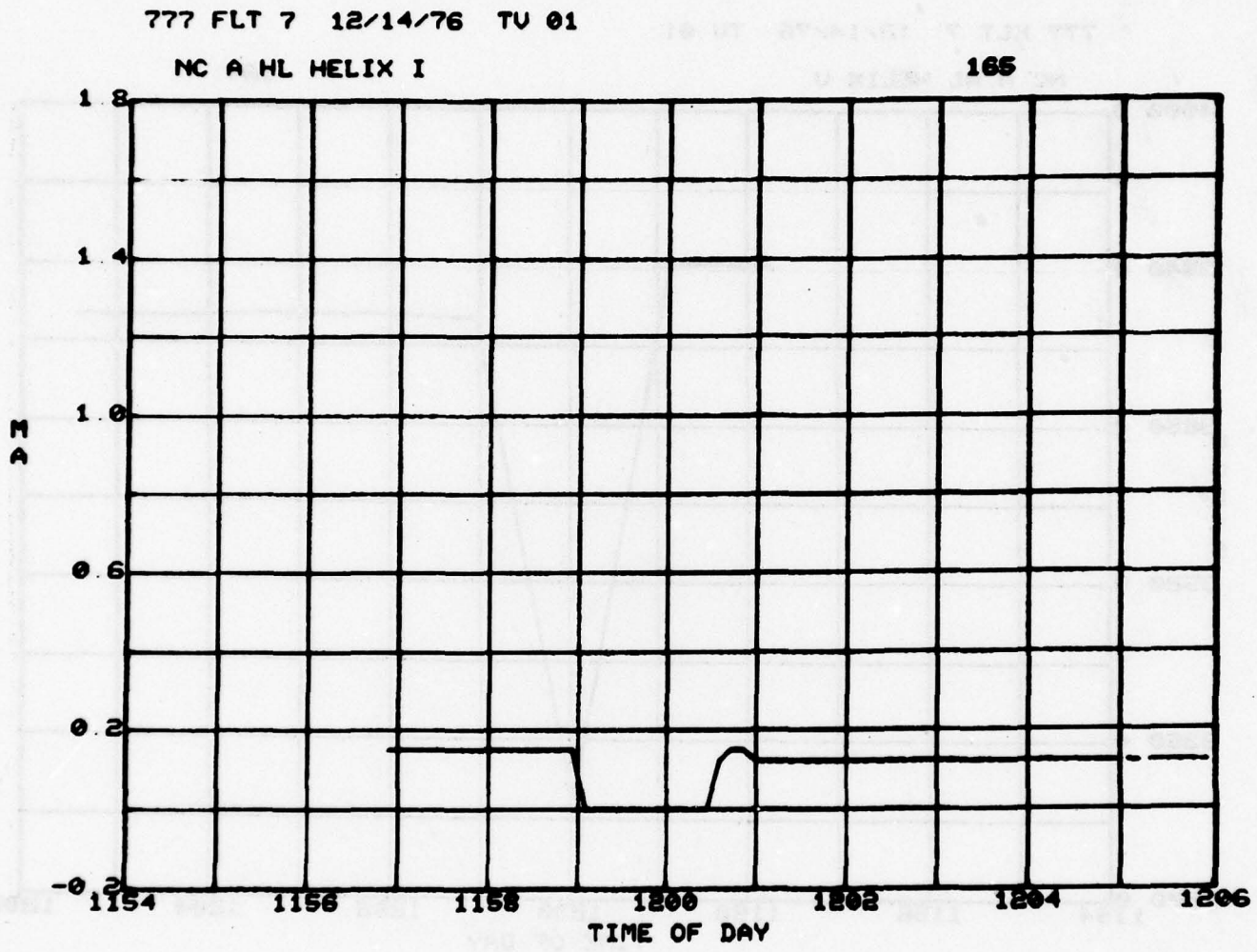
1204
1206
TIME OF DAY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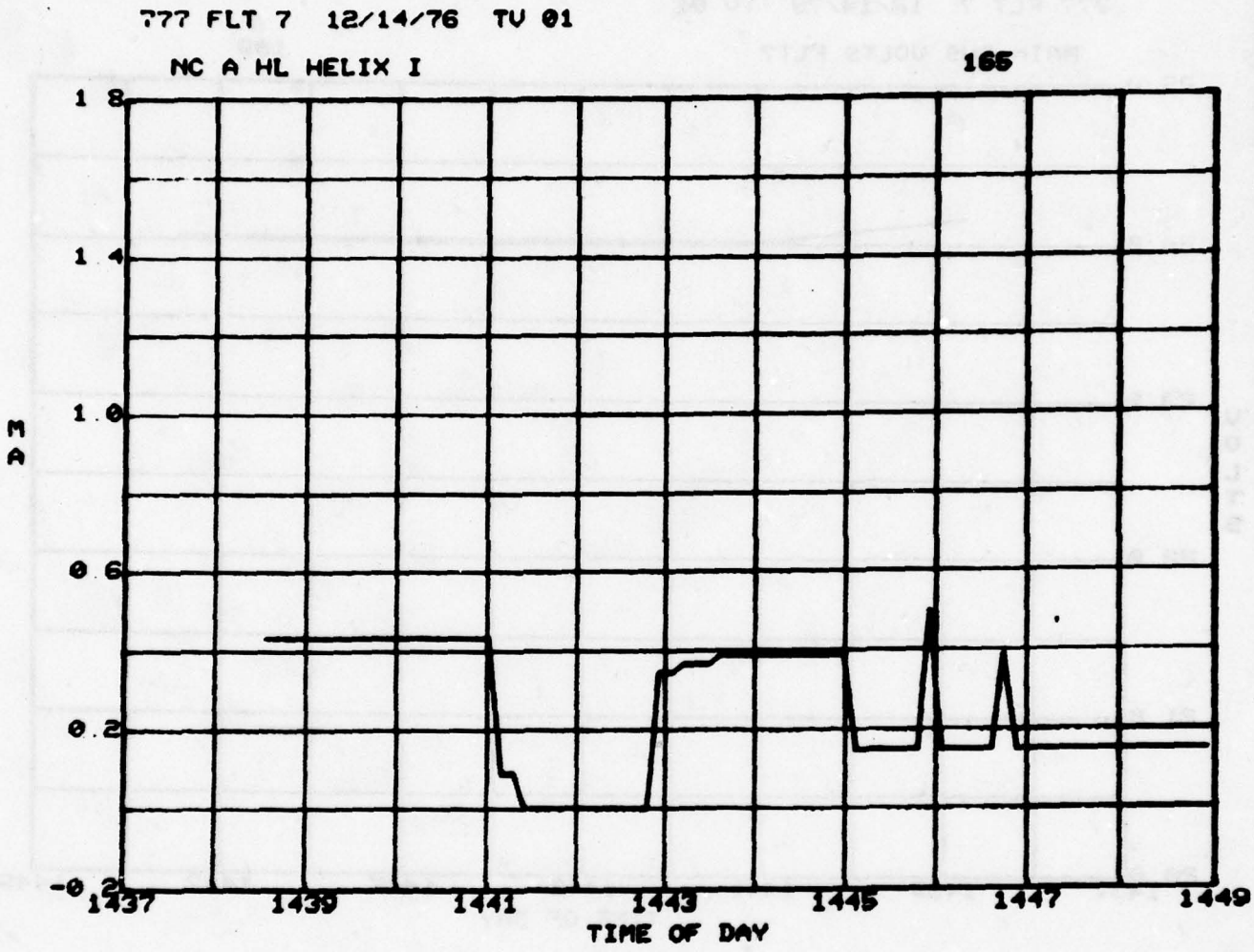
TIME OF DAY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MA
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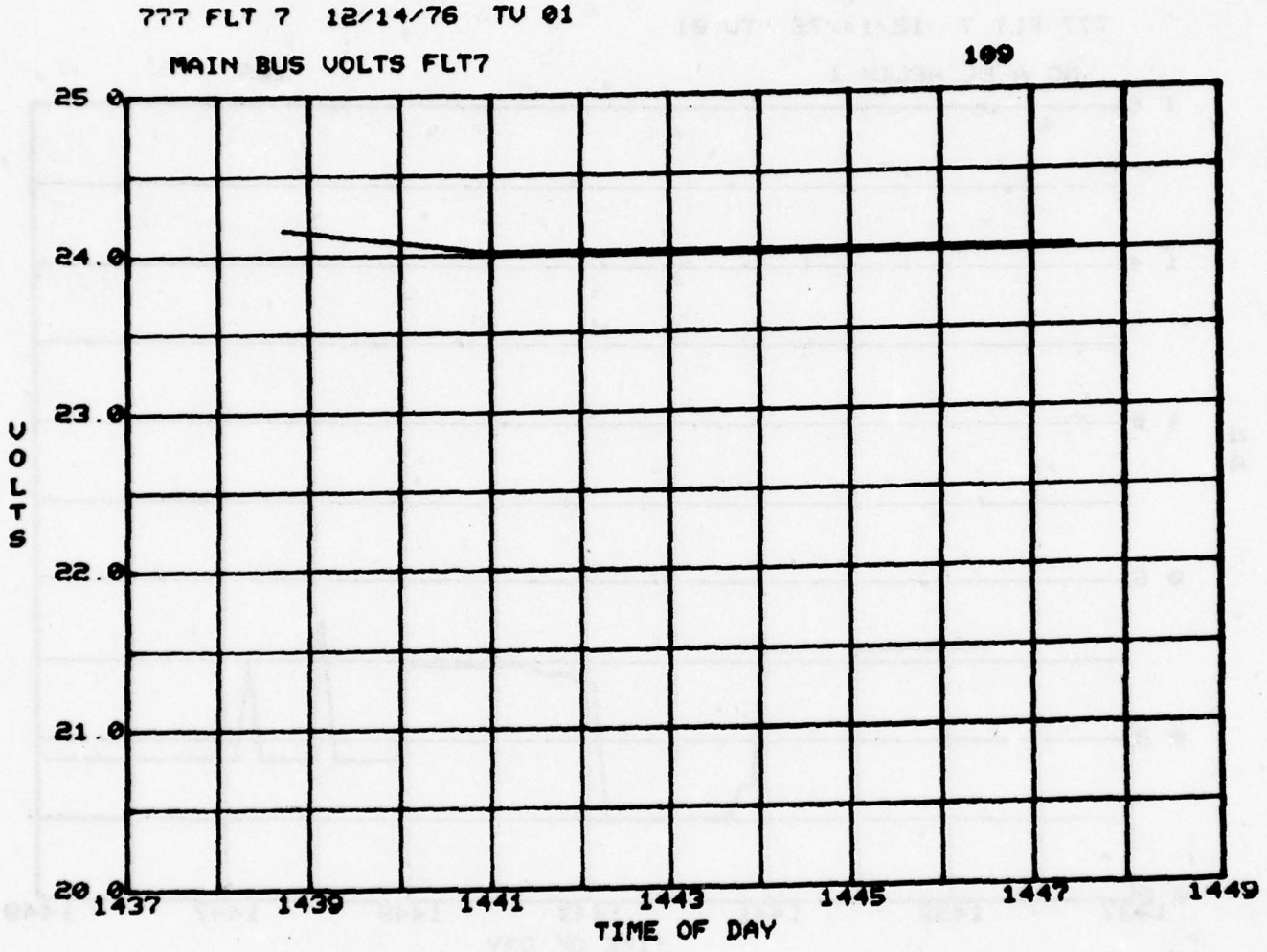
TIME OF DAY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MAIN BUS VOLTS FLT7
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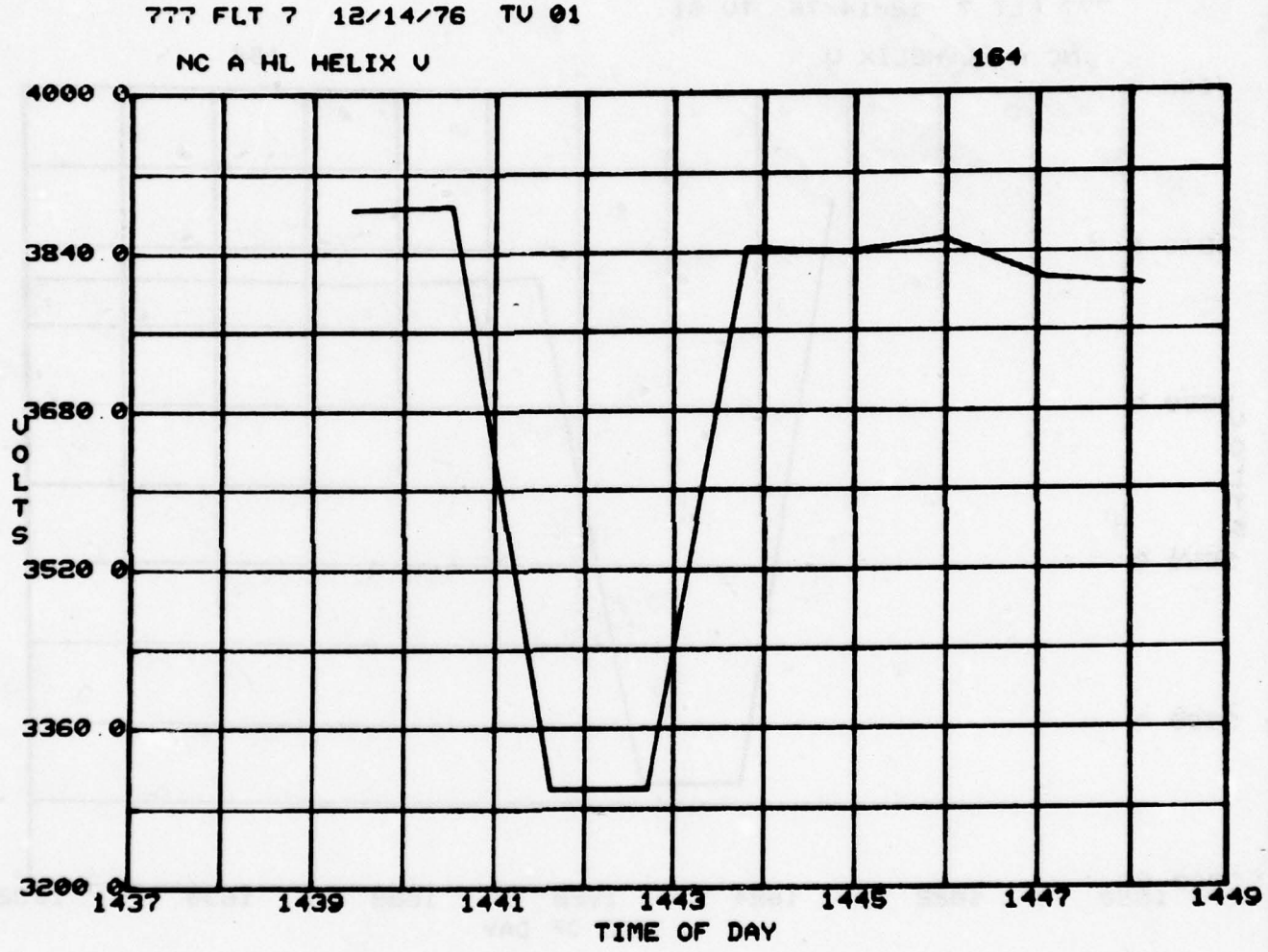
TIME OF DAY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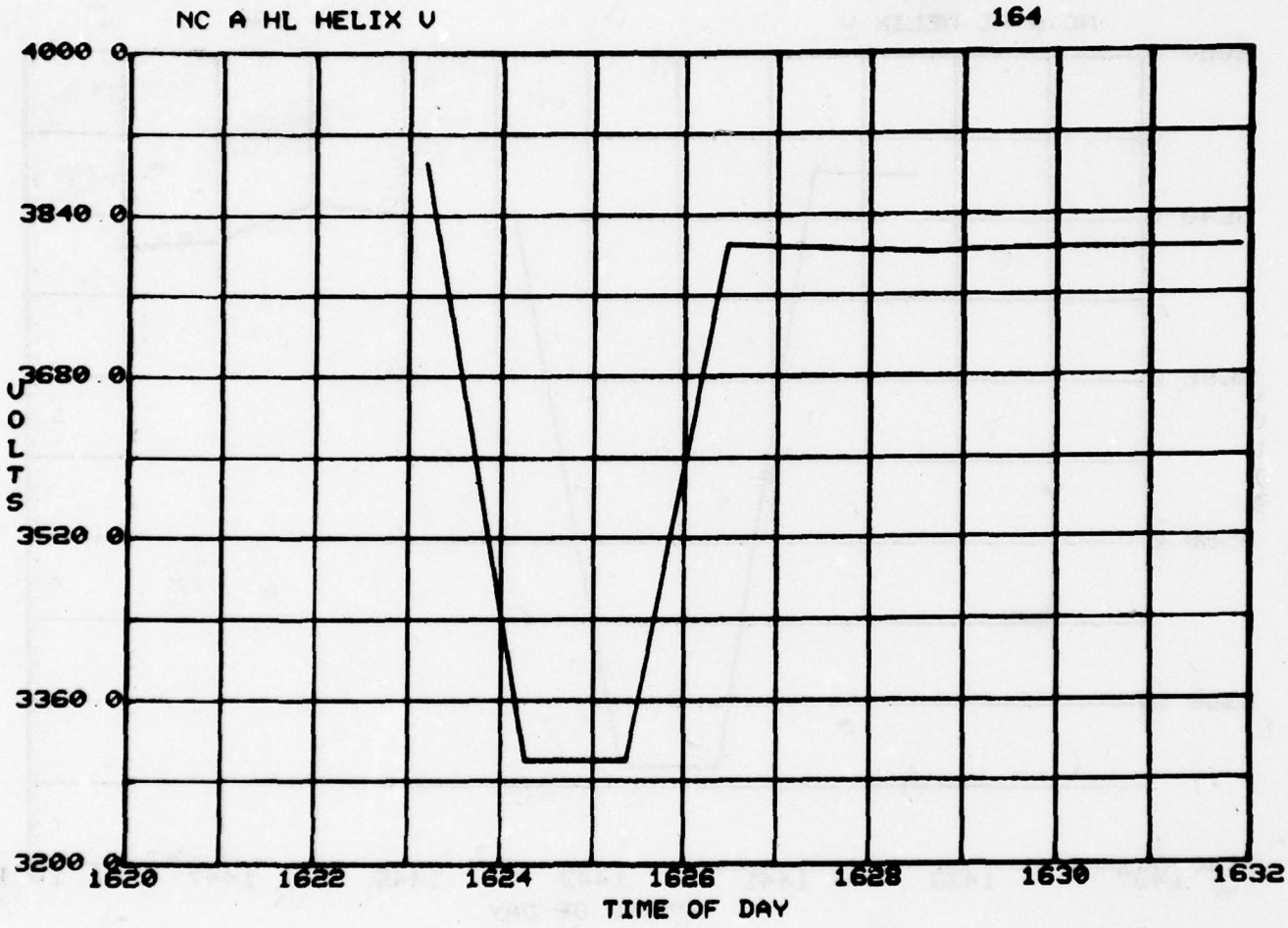
TIME OF DAY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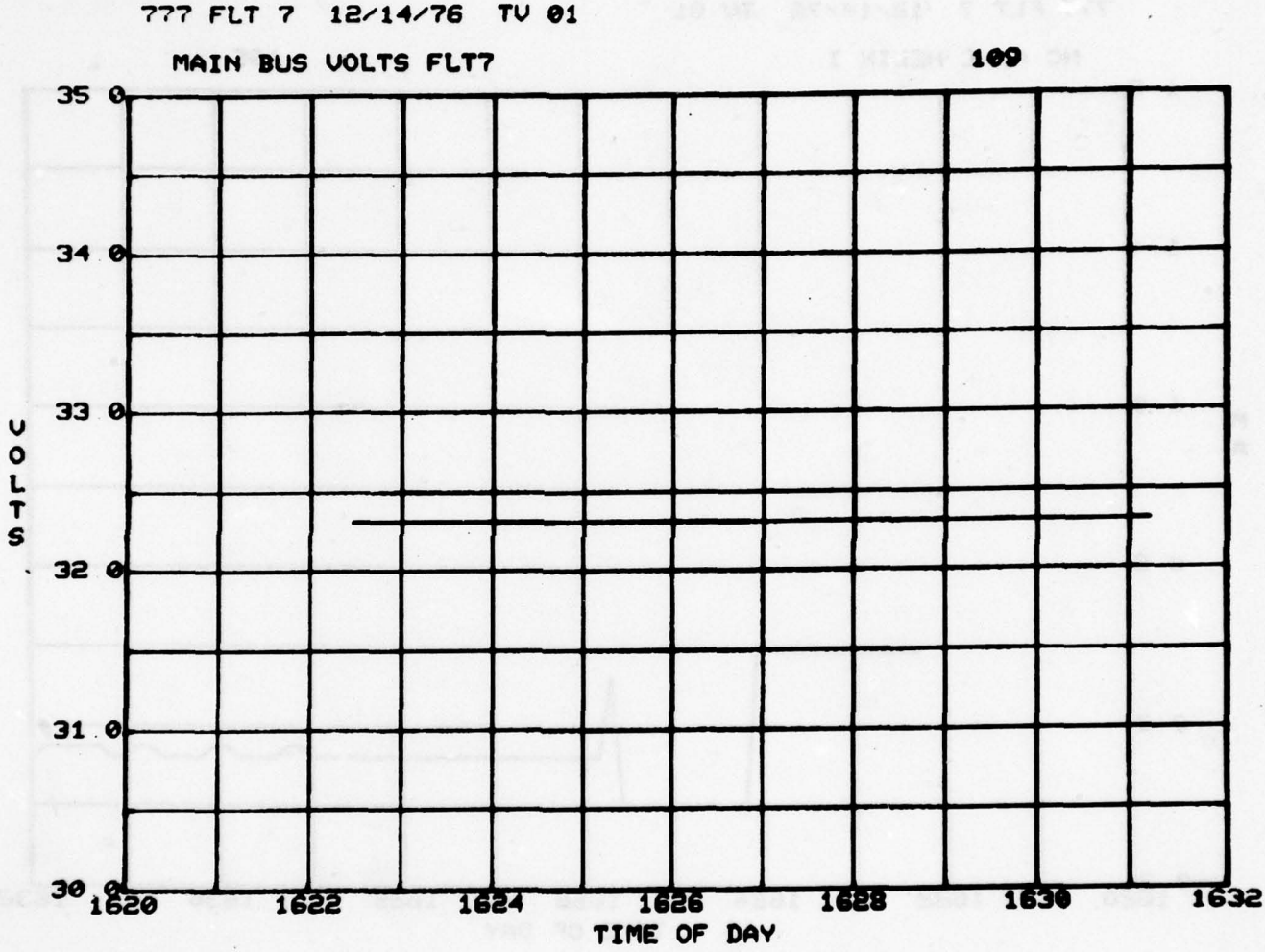
TIME OF DAY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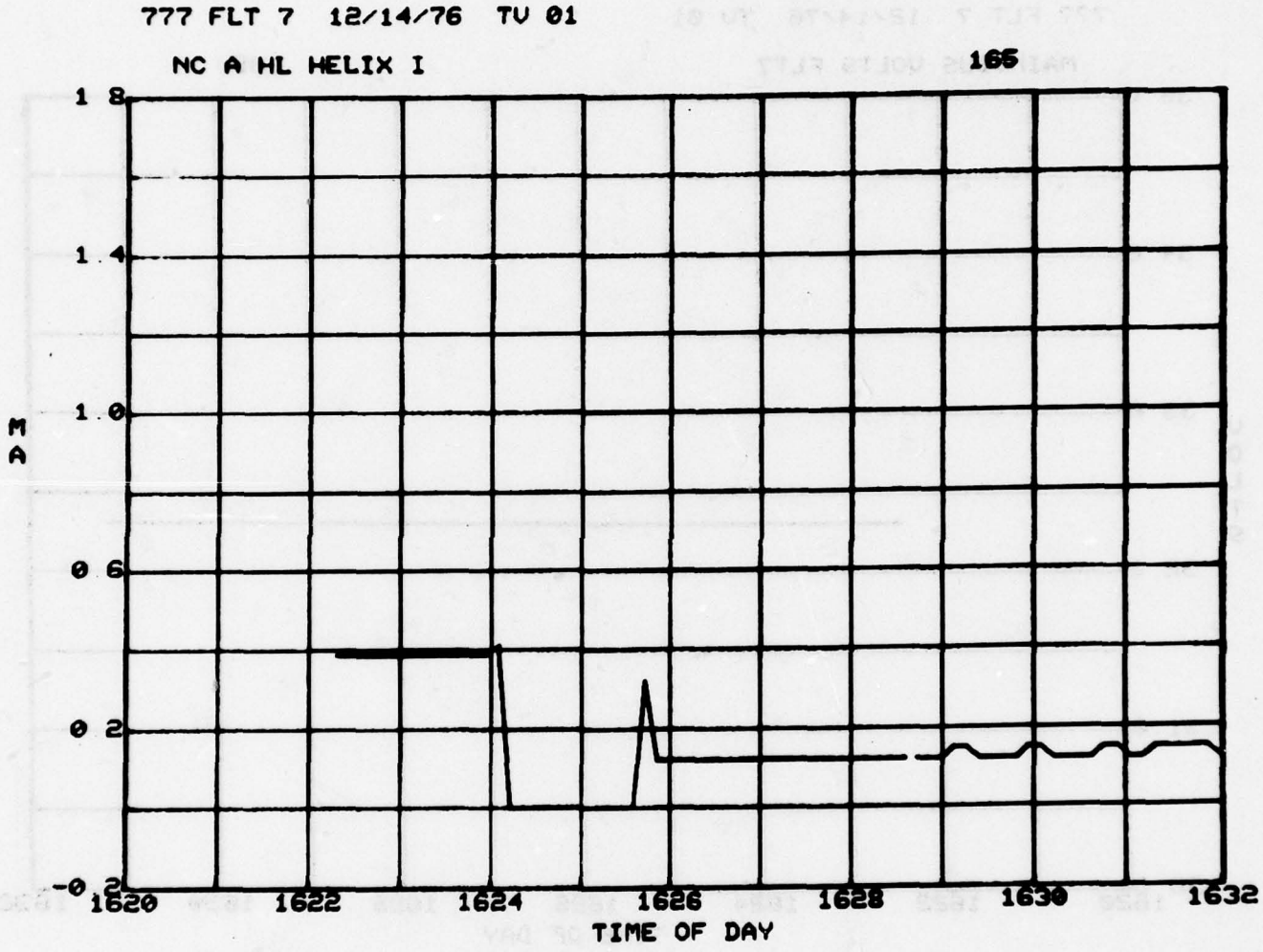
TIME OF DAY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A
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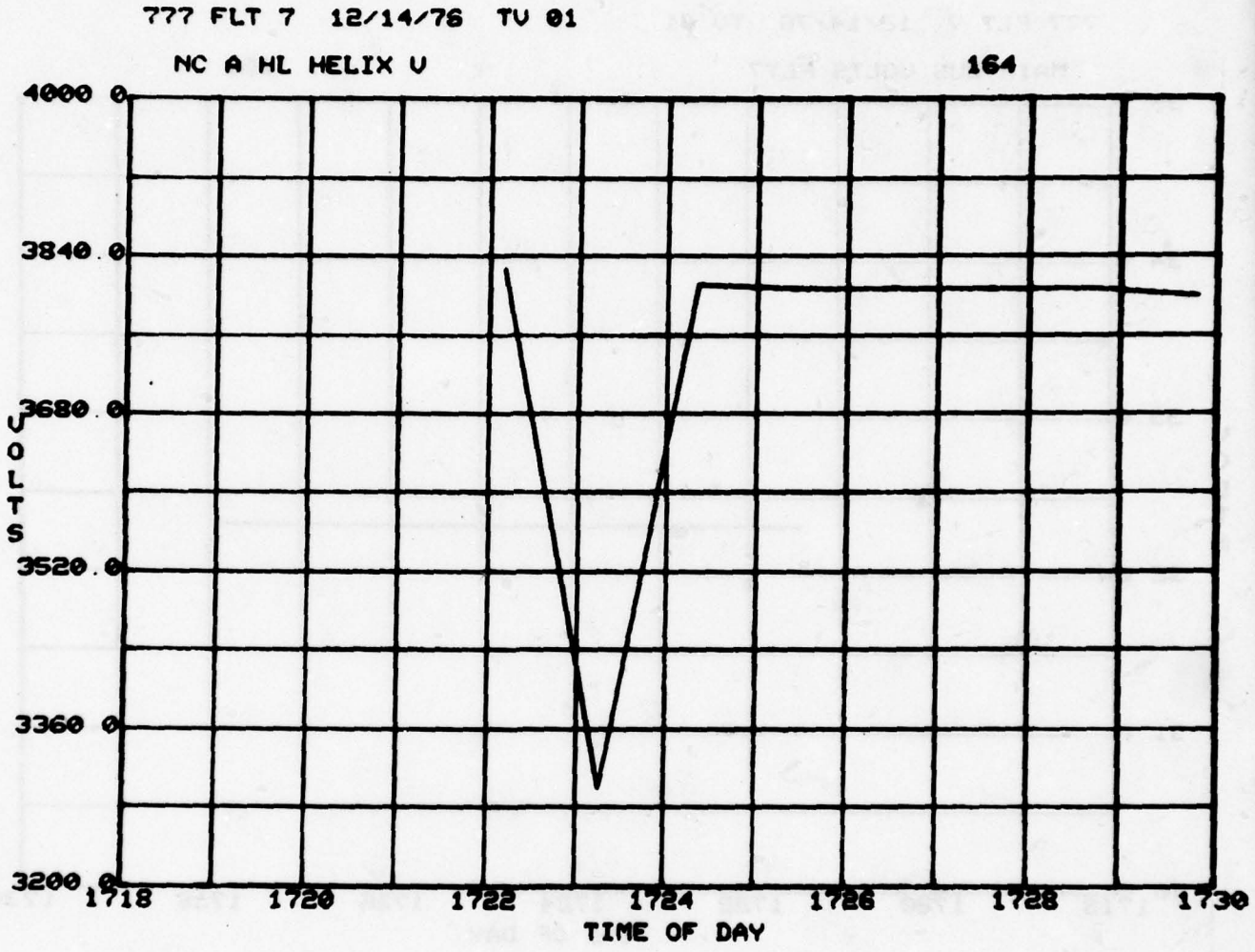
TIME OF DAY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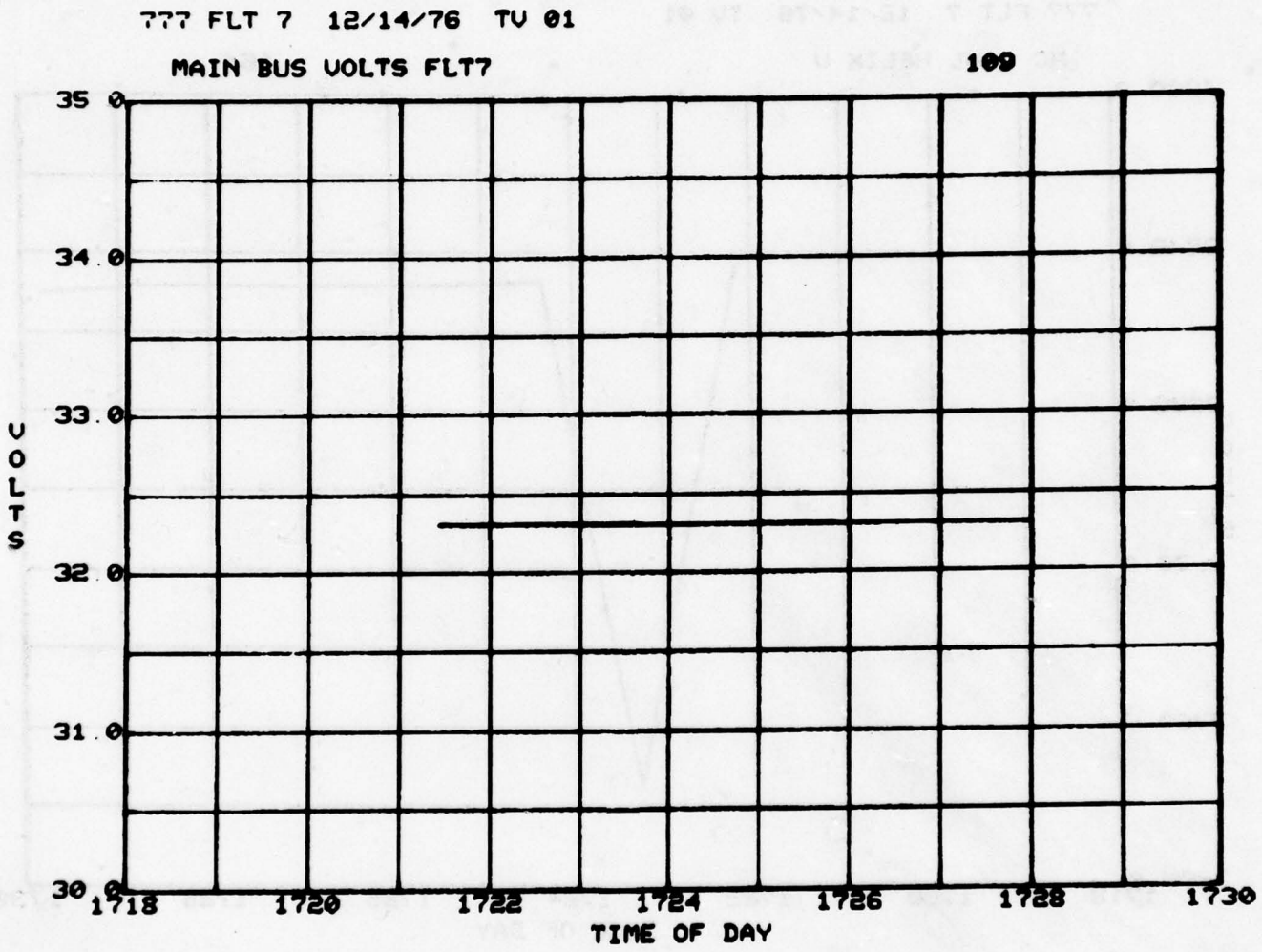
TIME OF DAY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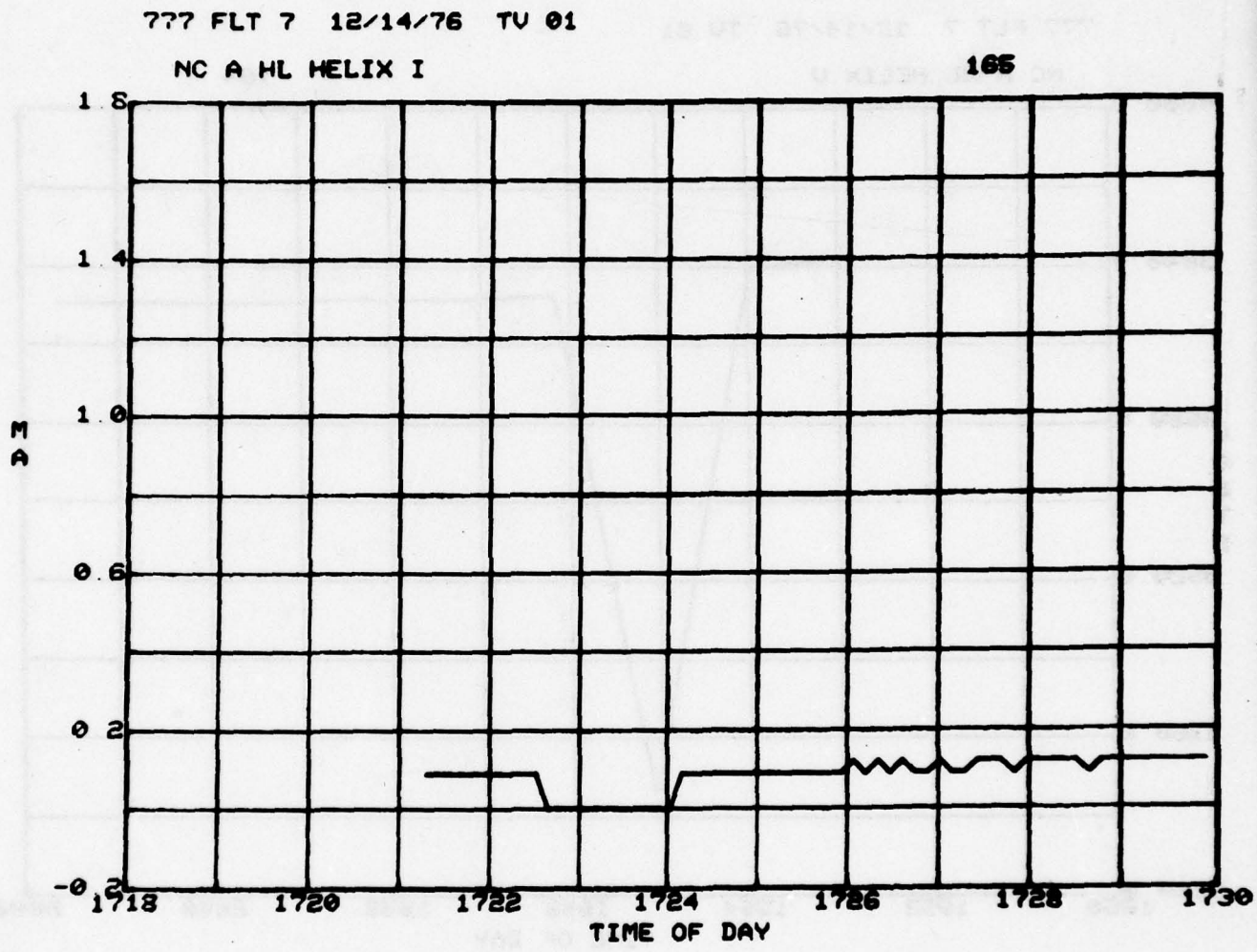
TIME OF DAY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1.8
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MA
1718
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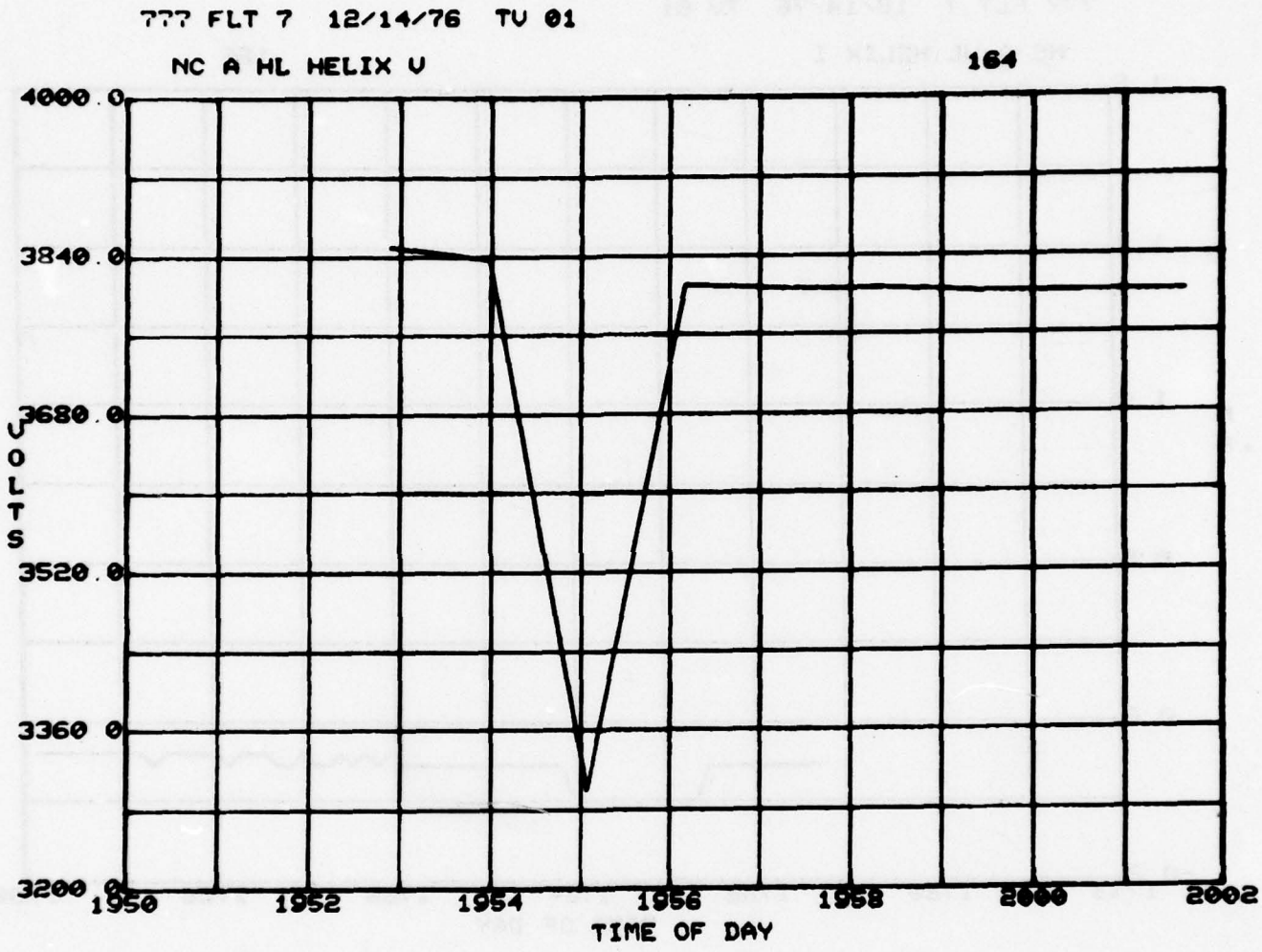
TIME OF DAY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VOLTS
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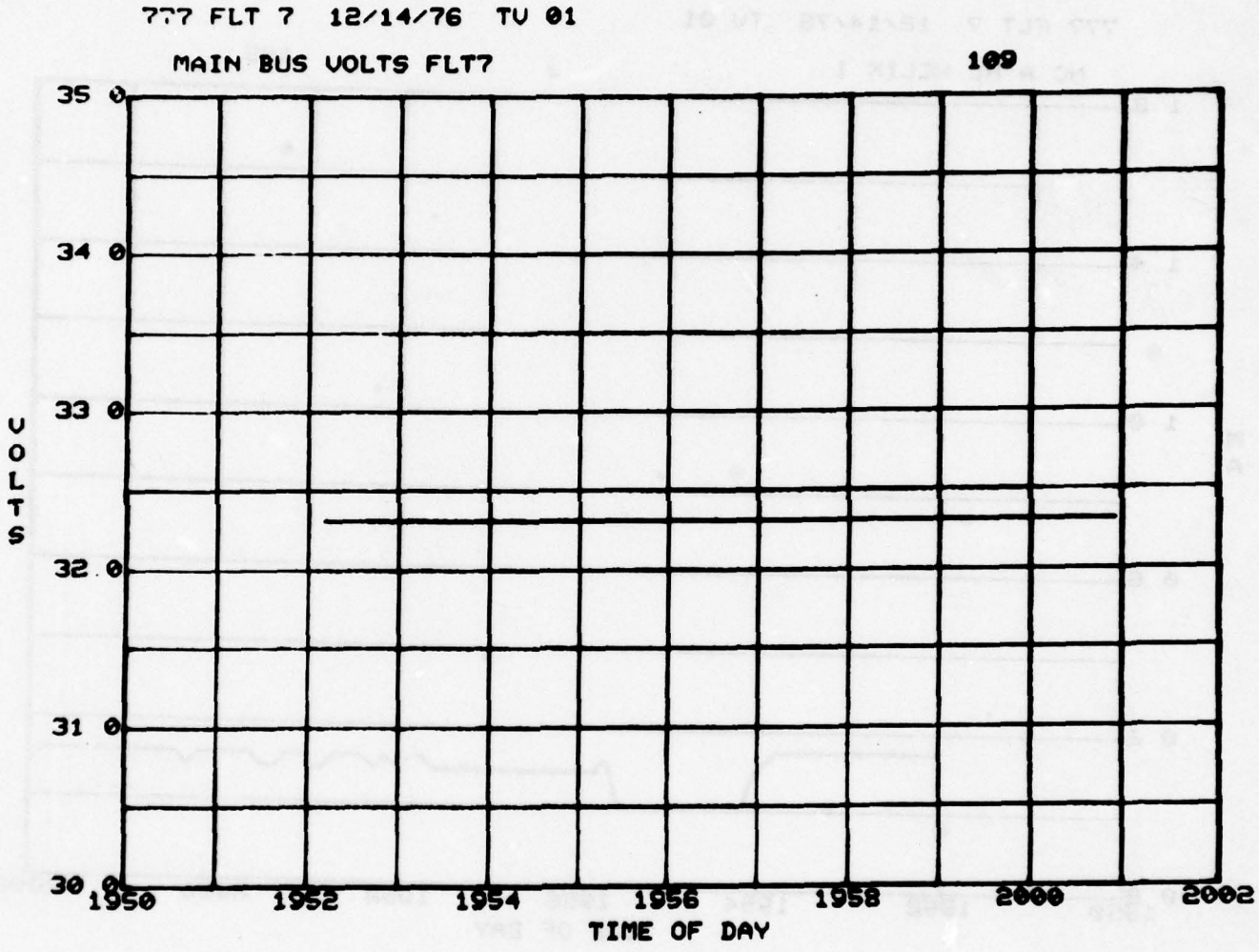
1952
1954
1956
1958
2000
2002
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
1950
1952
1954
1956
1958
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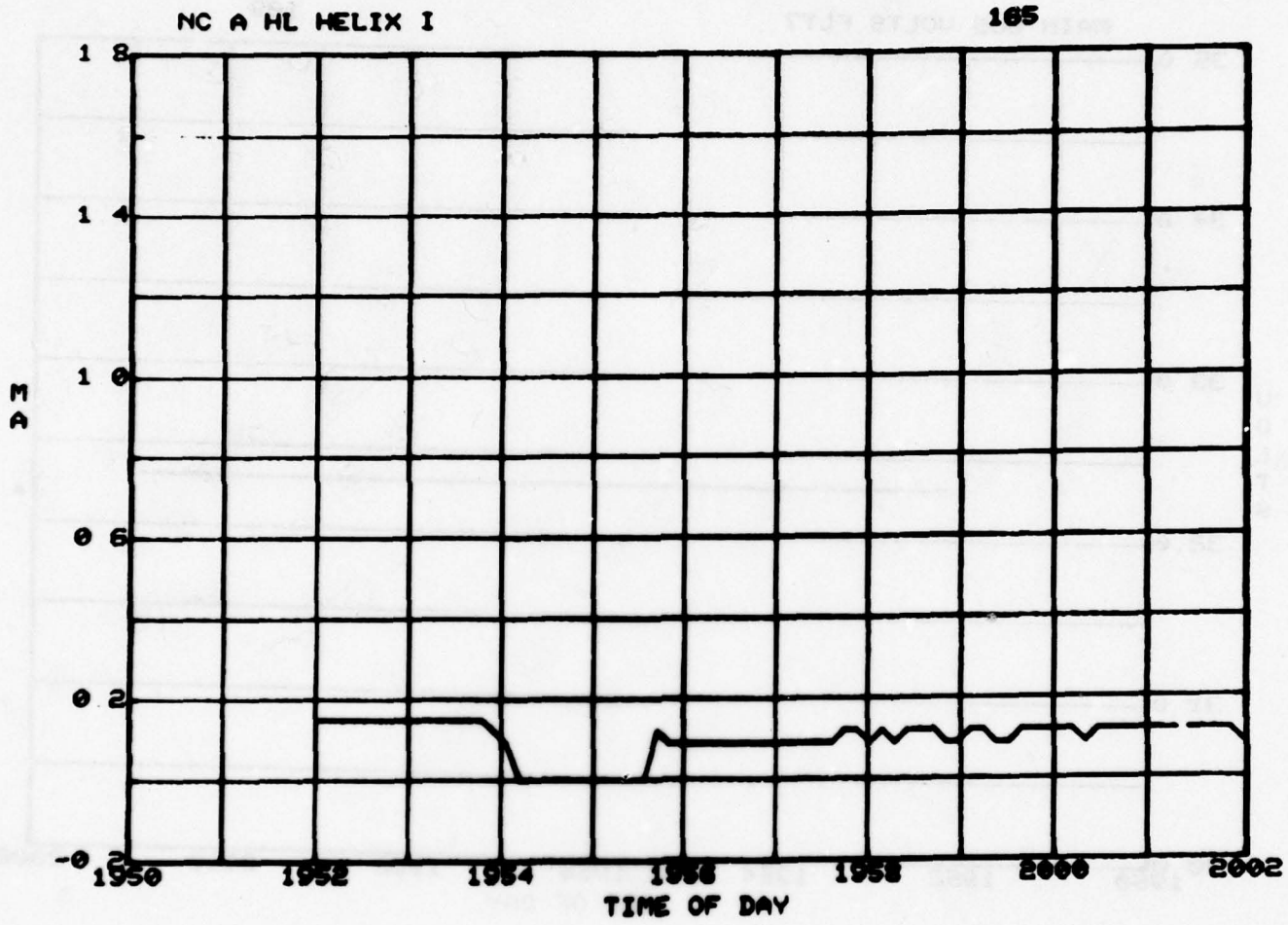
2002
TIME OF DAY


777 FLT 7 12/14/76 TV 01
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MA
1950
1952
1954
1956
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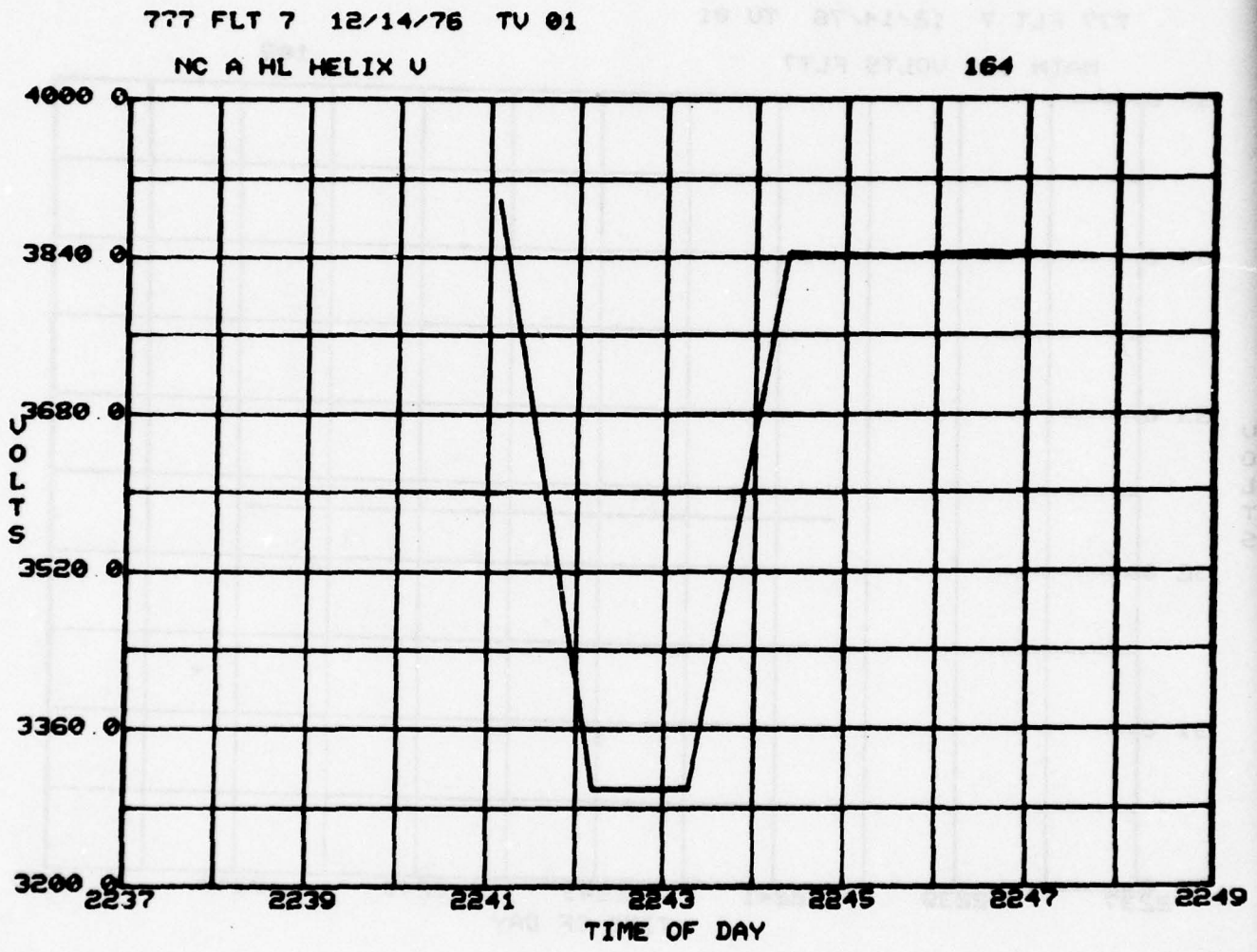
2002
TIME OF DAY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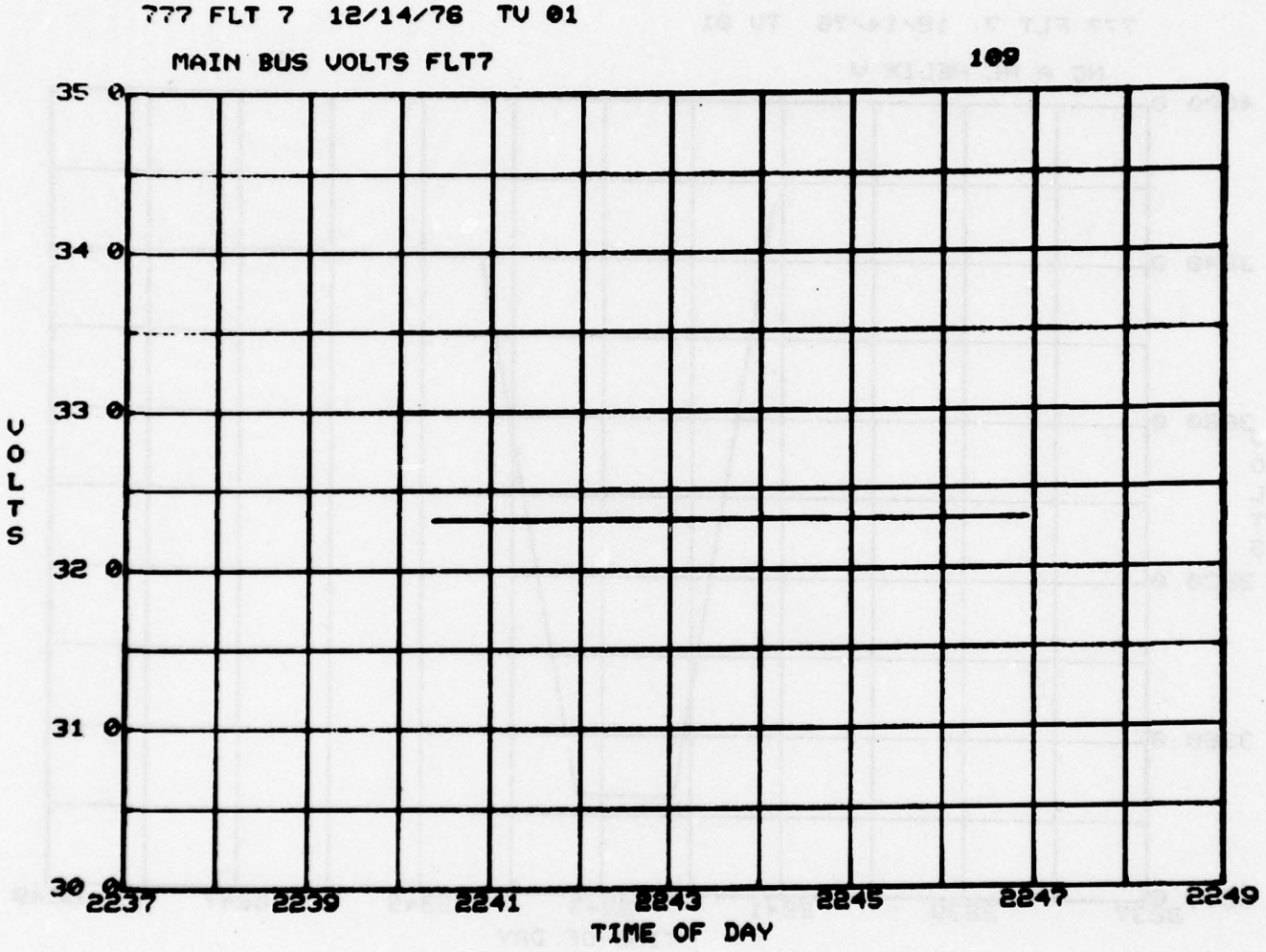
TIME OF DAY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MAIN BUS VOLTS FLT7
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2247
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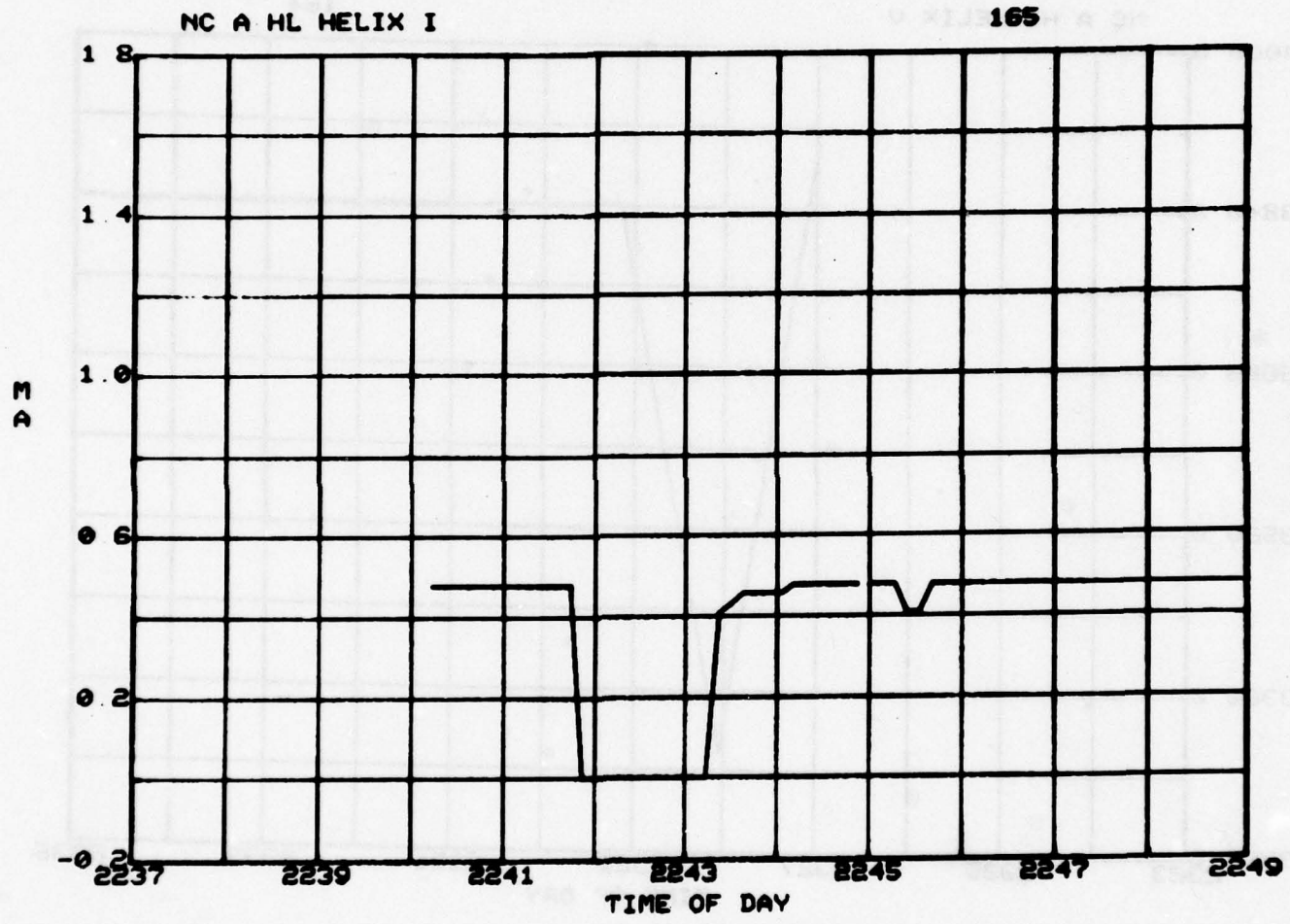
TIME OF DAY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2237
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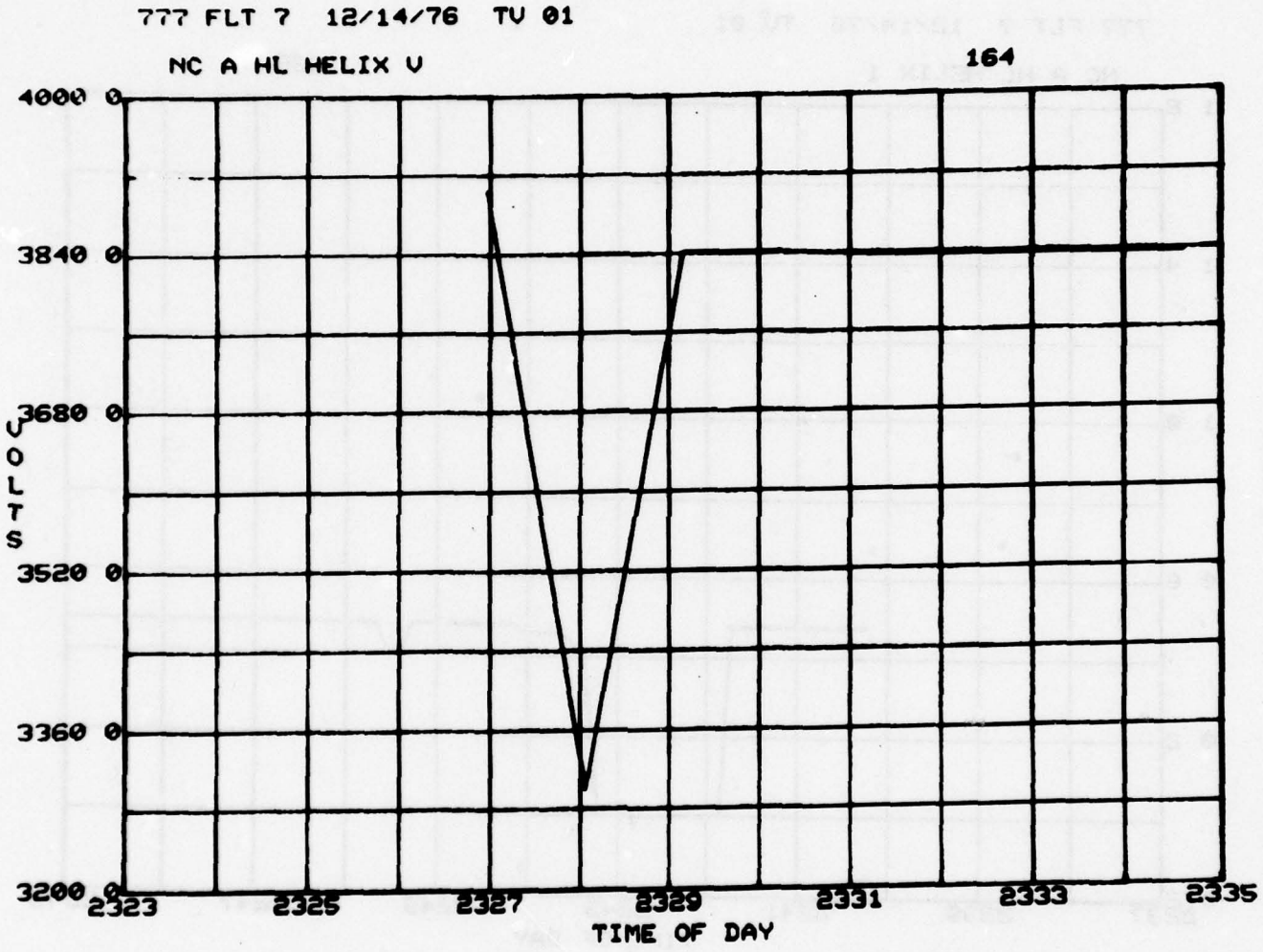
TIME OF DAY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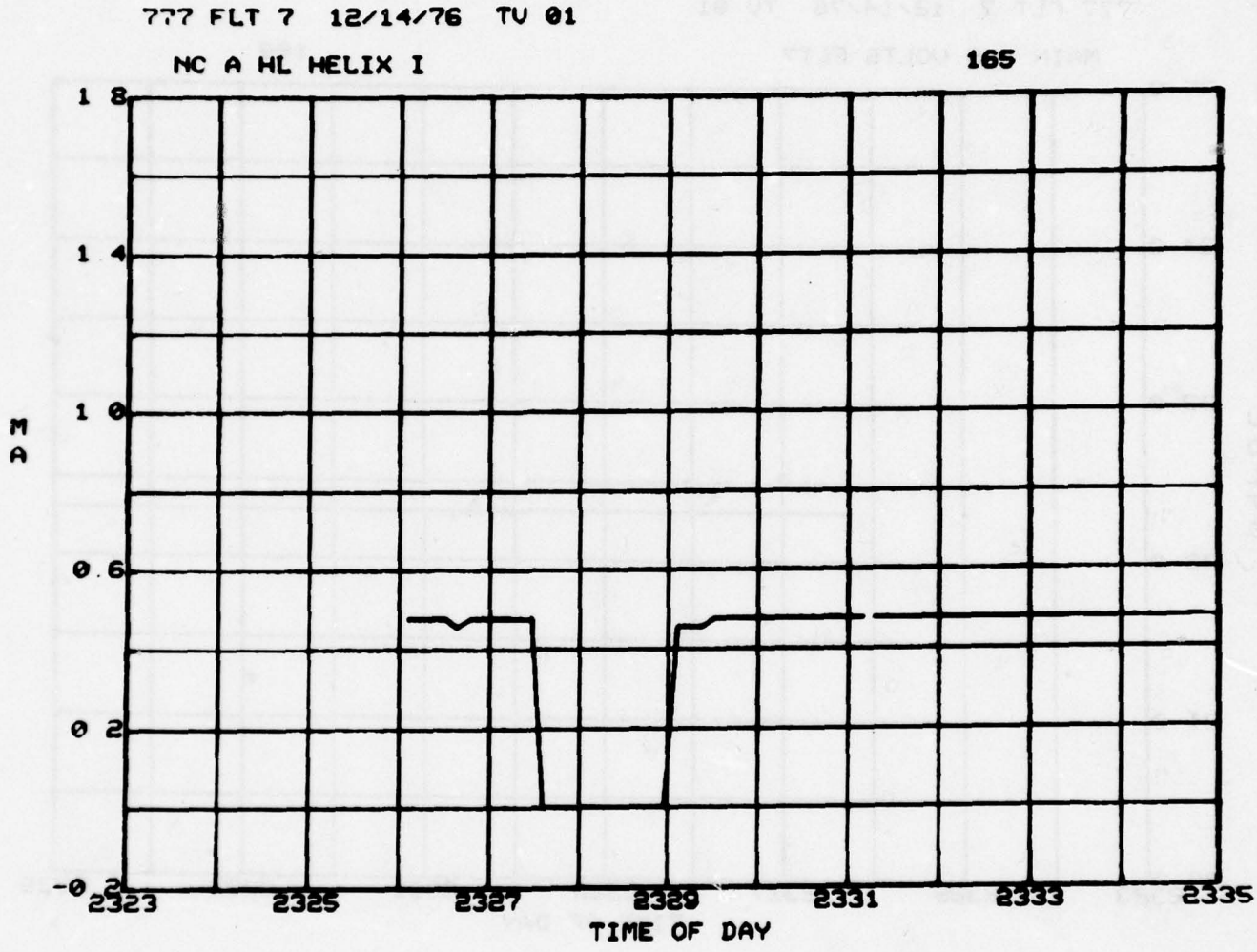
2331
2333
2335
TIME OF DAY


777 FLT 7 12/14/76 TU 01
NC A HL HELIX I
165
1 8
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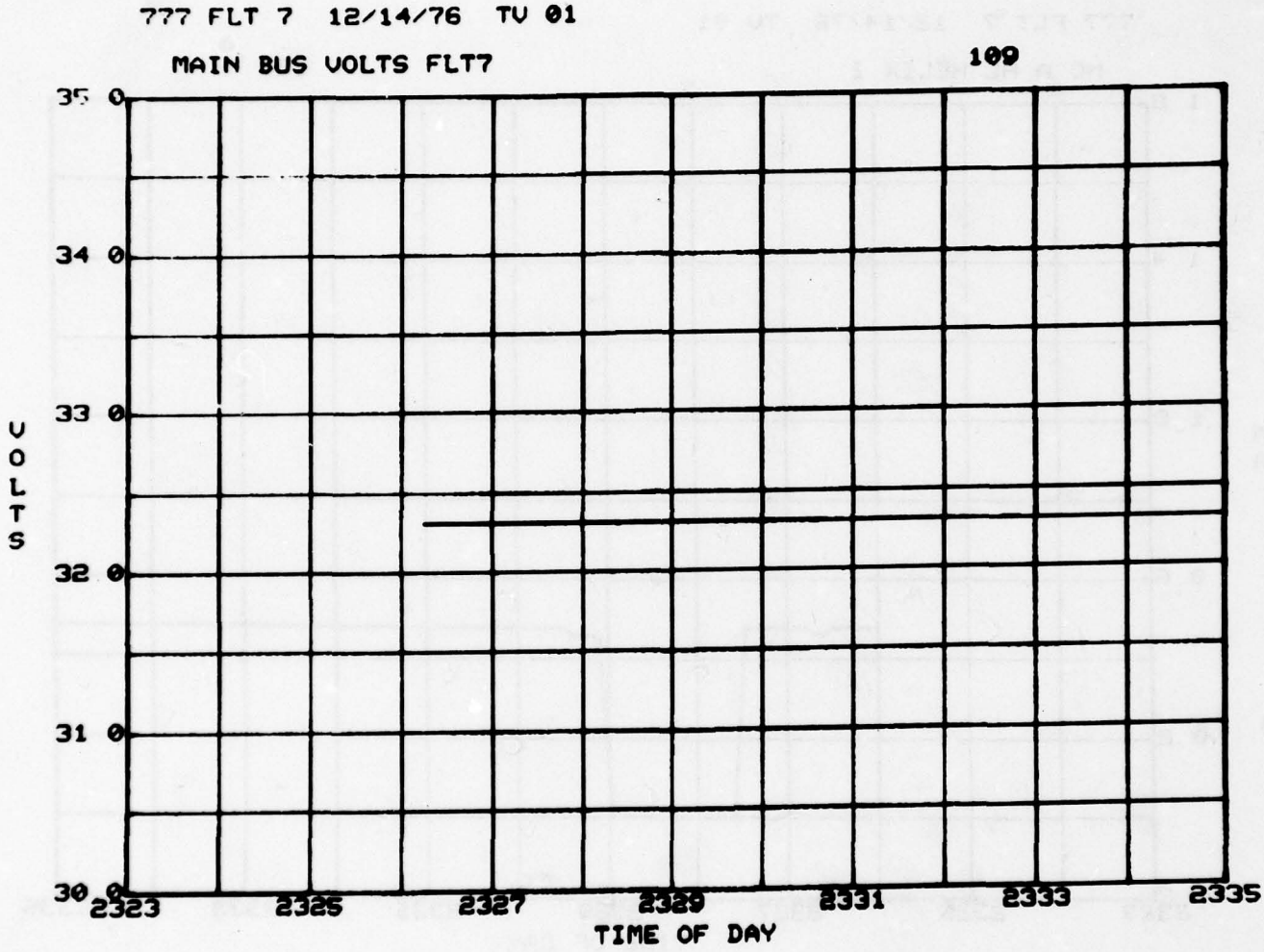
0 6
0 2
-0 2
M
A
2323
2325
2327
2329
2331
2333
2335
TIME OF DAY


777 FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
109
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32 0
31 0
30 0
VOLTS
2323
2325
2327
2329
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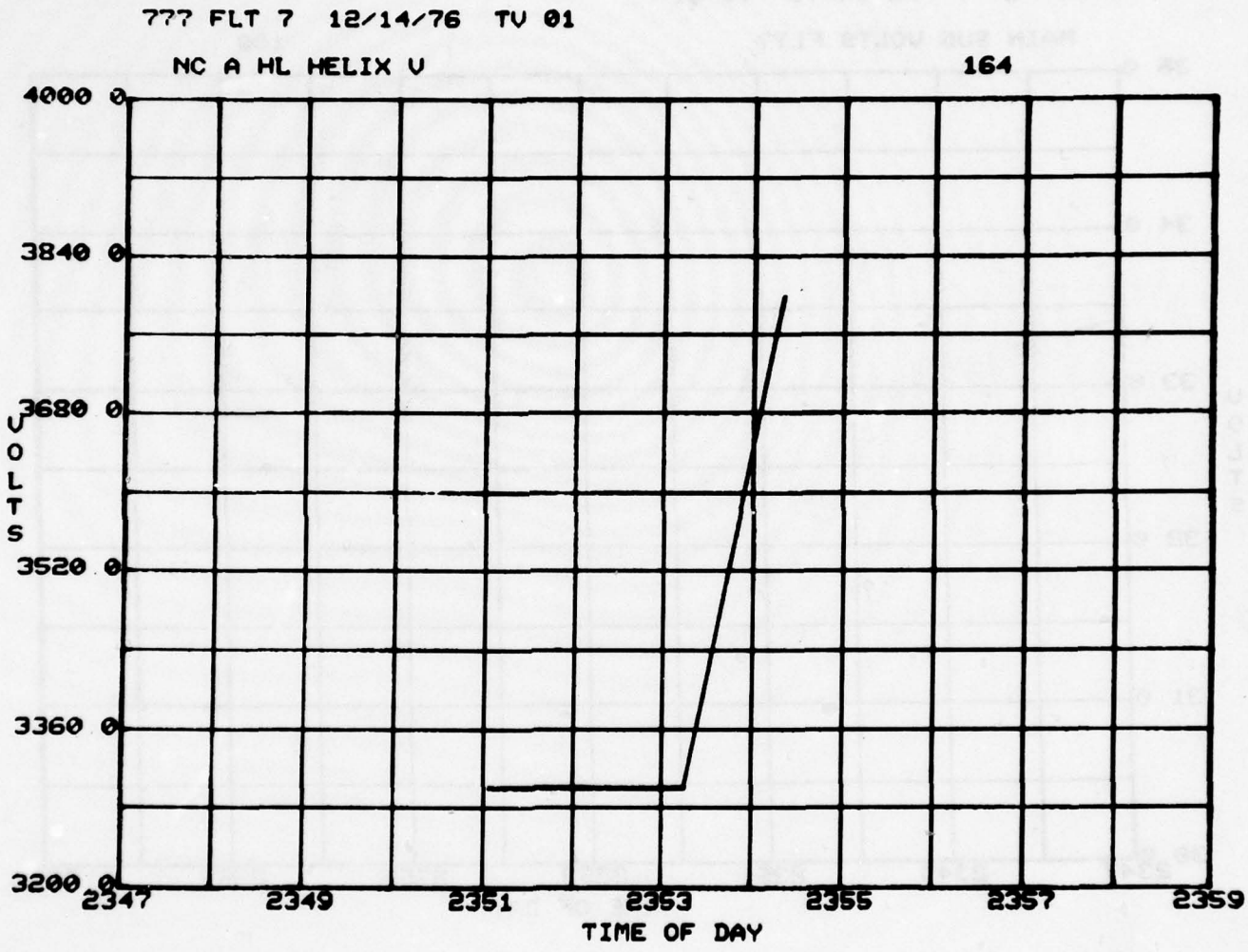
2333
2335
TIME OF DAY


777 FLT 7 12/14/76 TV 01
NC A HL HELIX V
164
4000 0
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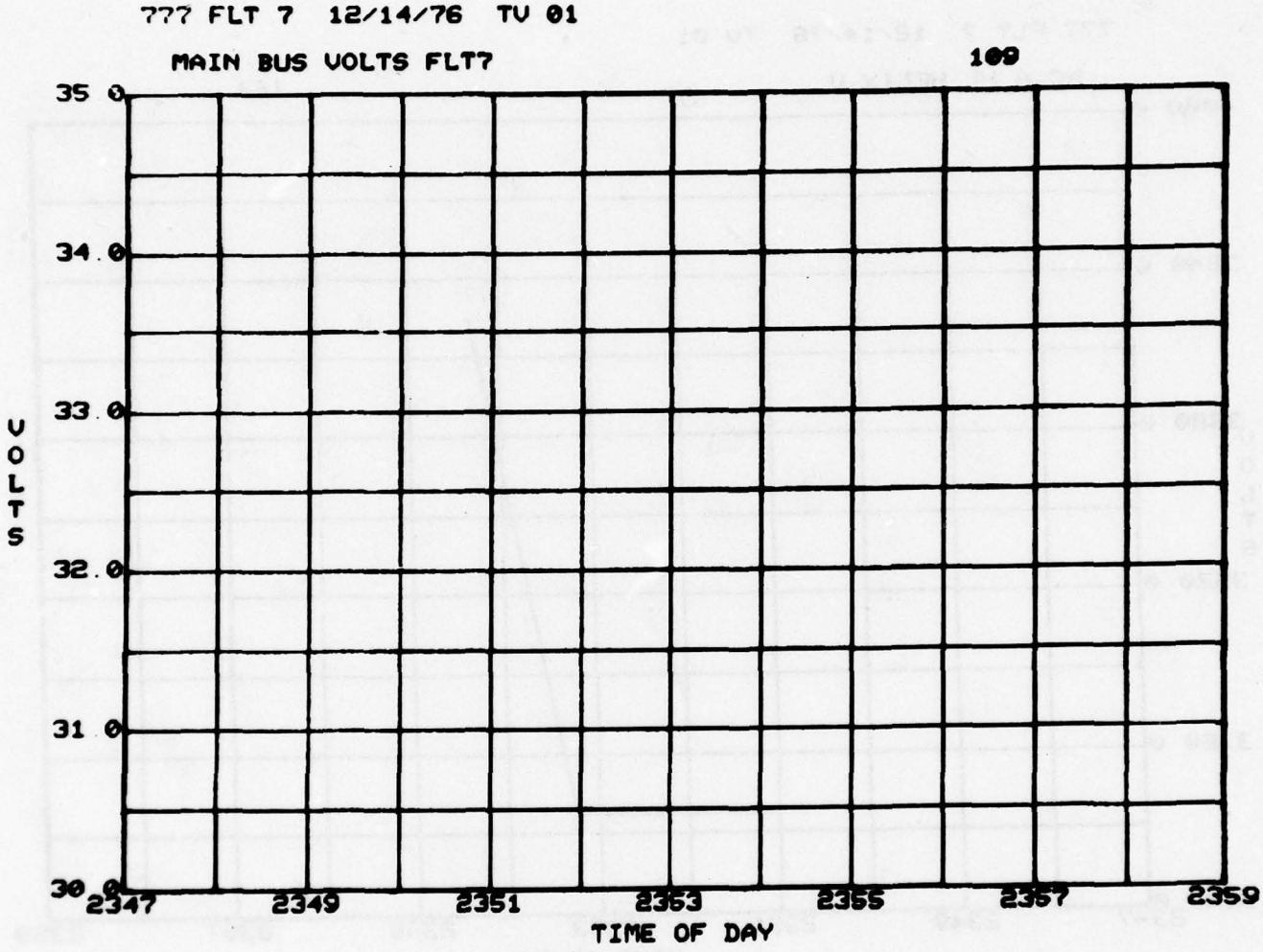
3200 0
VOLTS
2347
2349
2351
2353
2355
2357
2359
TIME OF DAY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MAIN BUS VOLTS FLT7
100
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33.0
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31.0
30.0
VOLTS
2347
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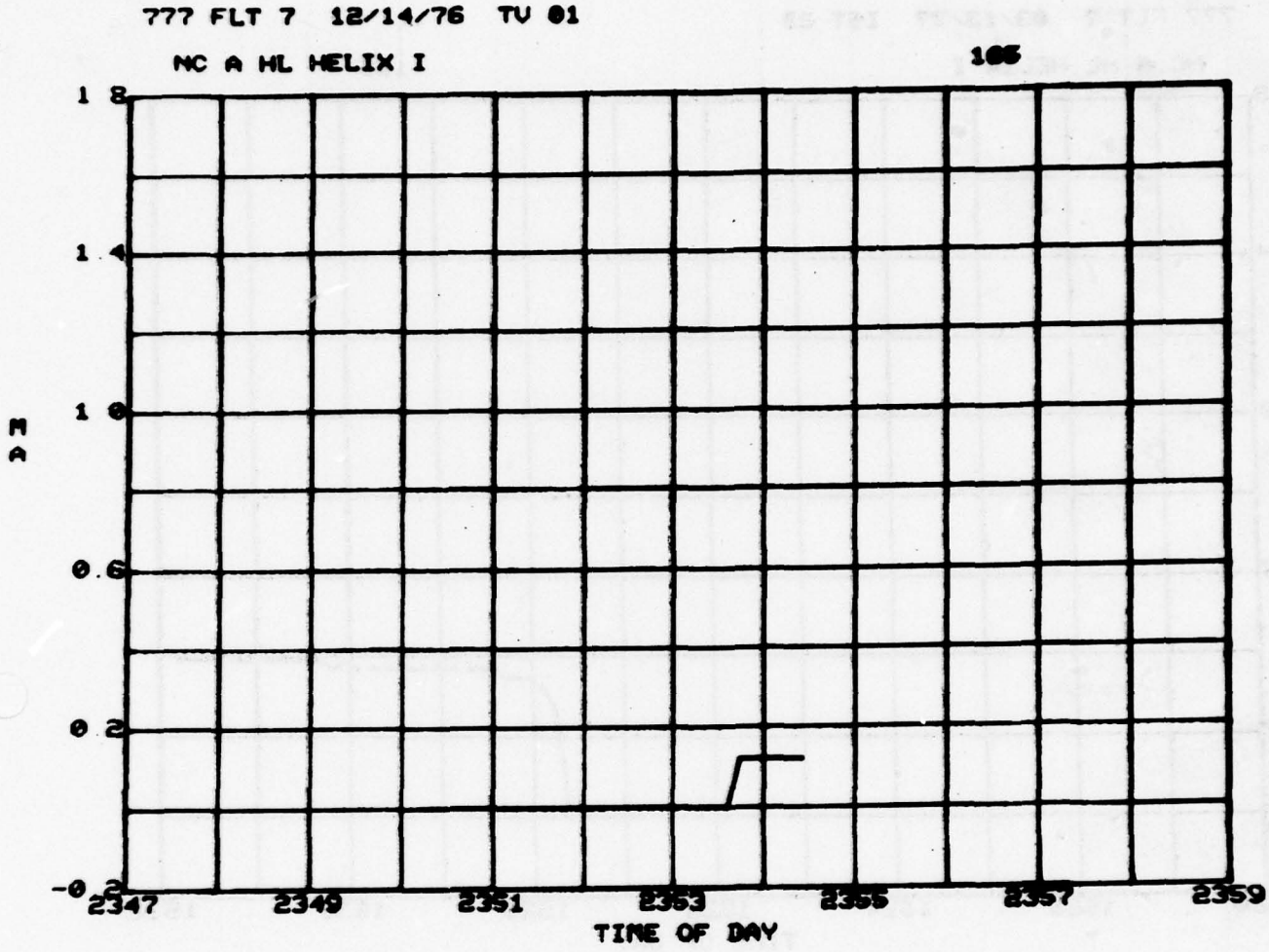
2351
2353
2355
2357
2359
TIME OF DAY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NC A HL HELIX I
105
1 8
1 4
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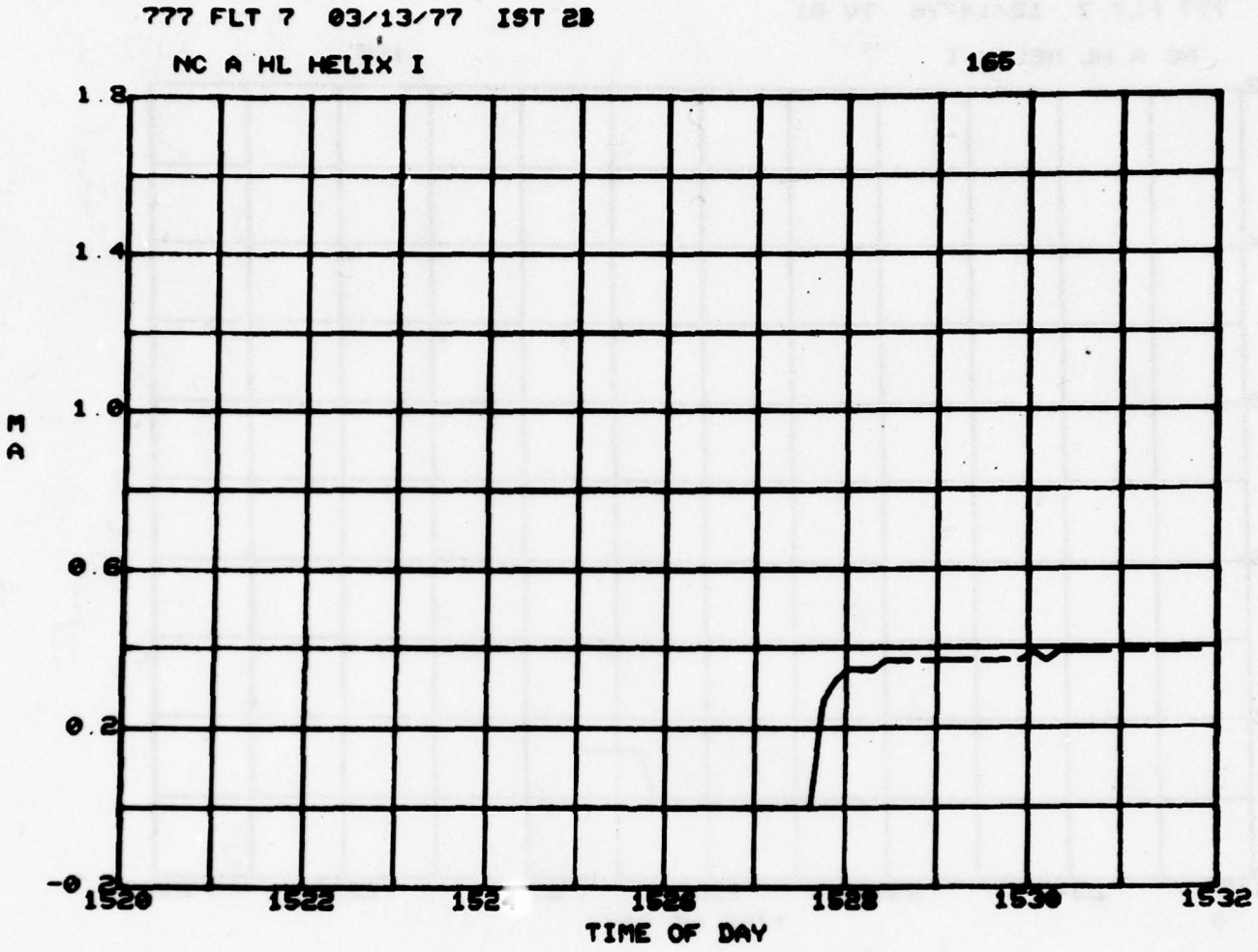
0.6
0 2
-0 2
MA
2347
2349
2351
2353
2355
2357
2359
TIME OF DAY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NC A HL HELIX I
165
1.8
1.4
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MA
1520
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1524
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1528
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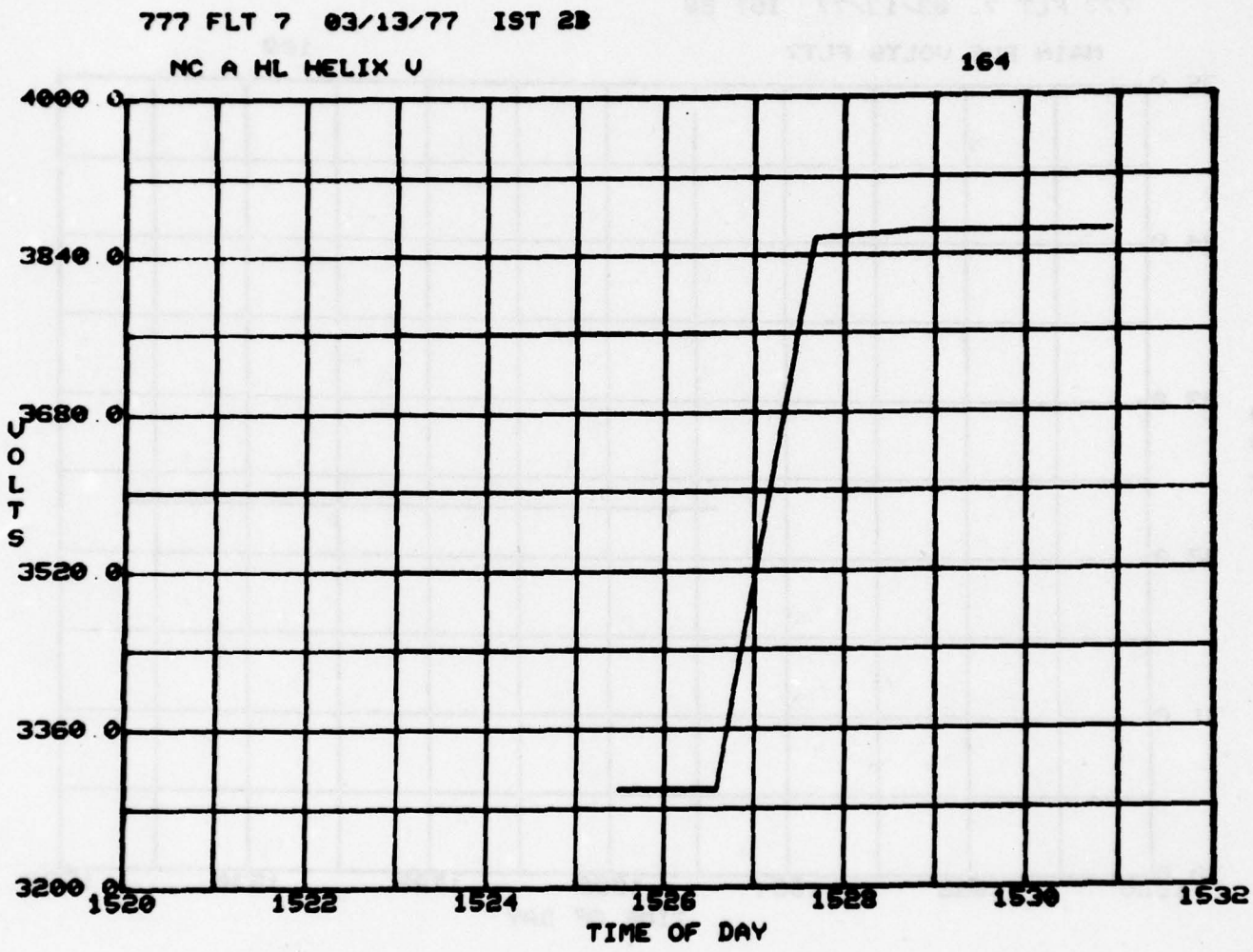
1532
TIME OF DAY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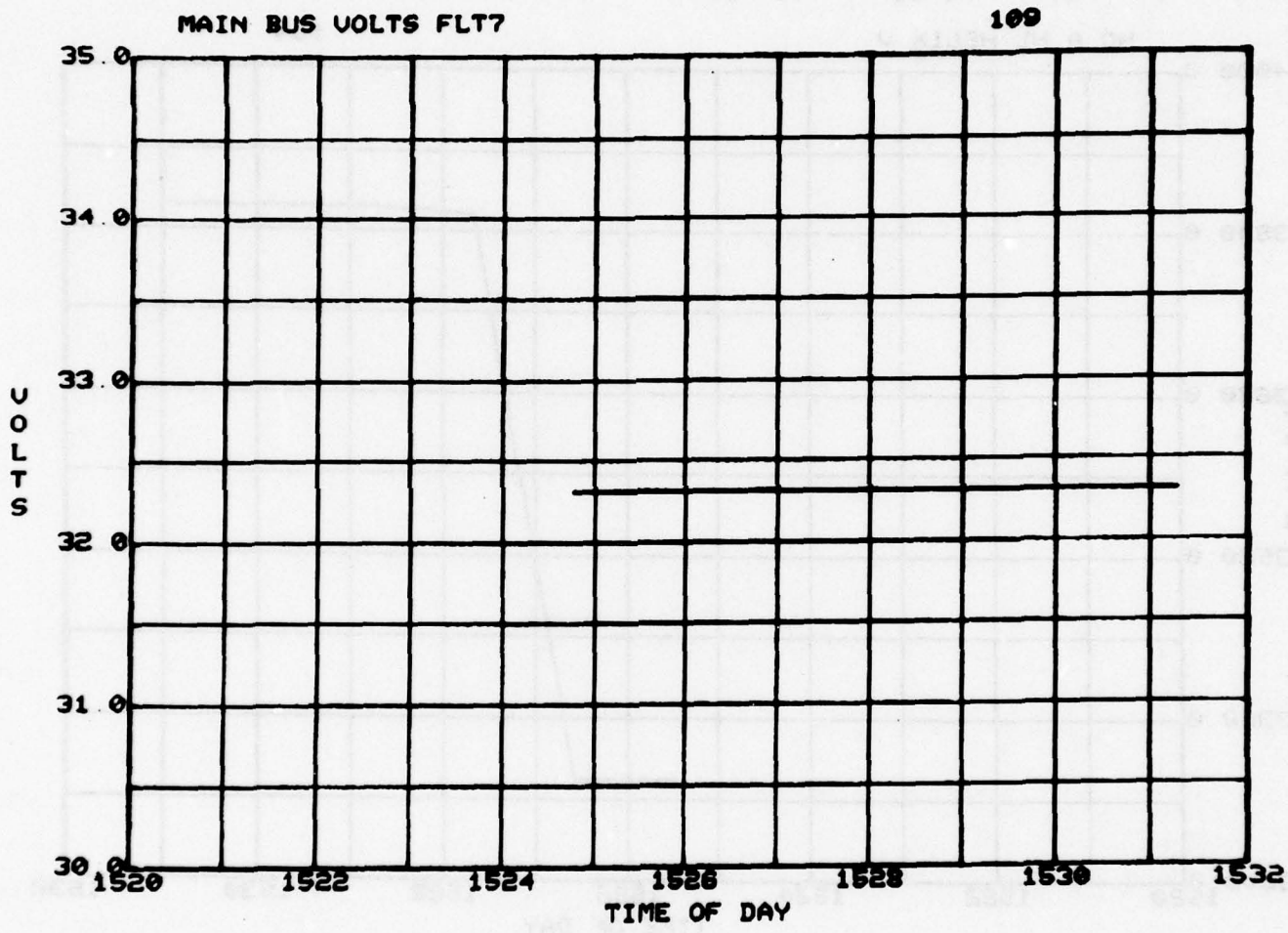
3200.0
VOLTS
1520
1522
1524
1526
1528
1530
1532
TIME OF DAY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MAIN BUS VOLTS FLT7
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35.0
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31.0
30.0
VOLTS
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1524
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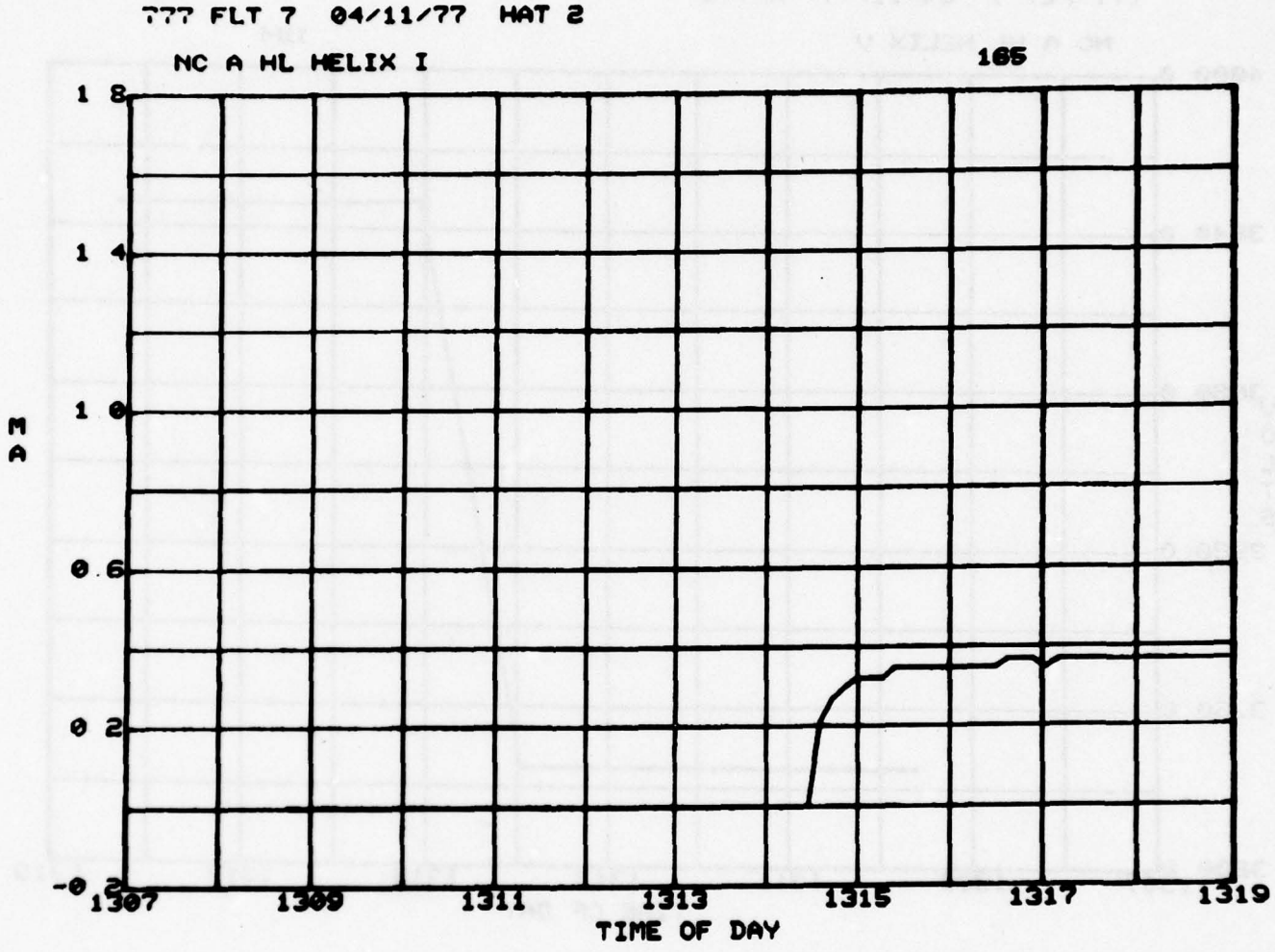
1530
1532
TIME OF DAY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NC A HL HELIX I
185
1 8
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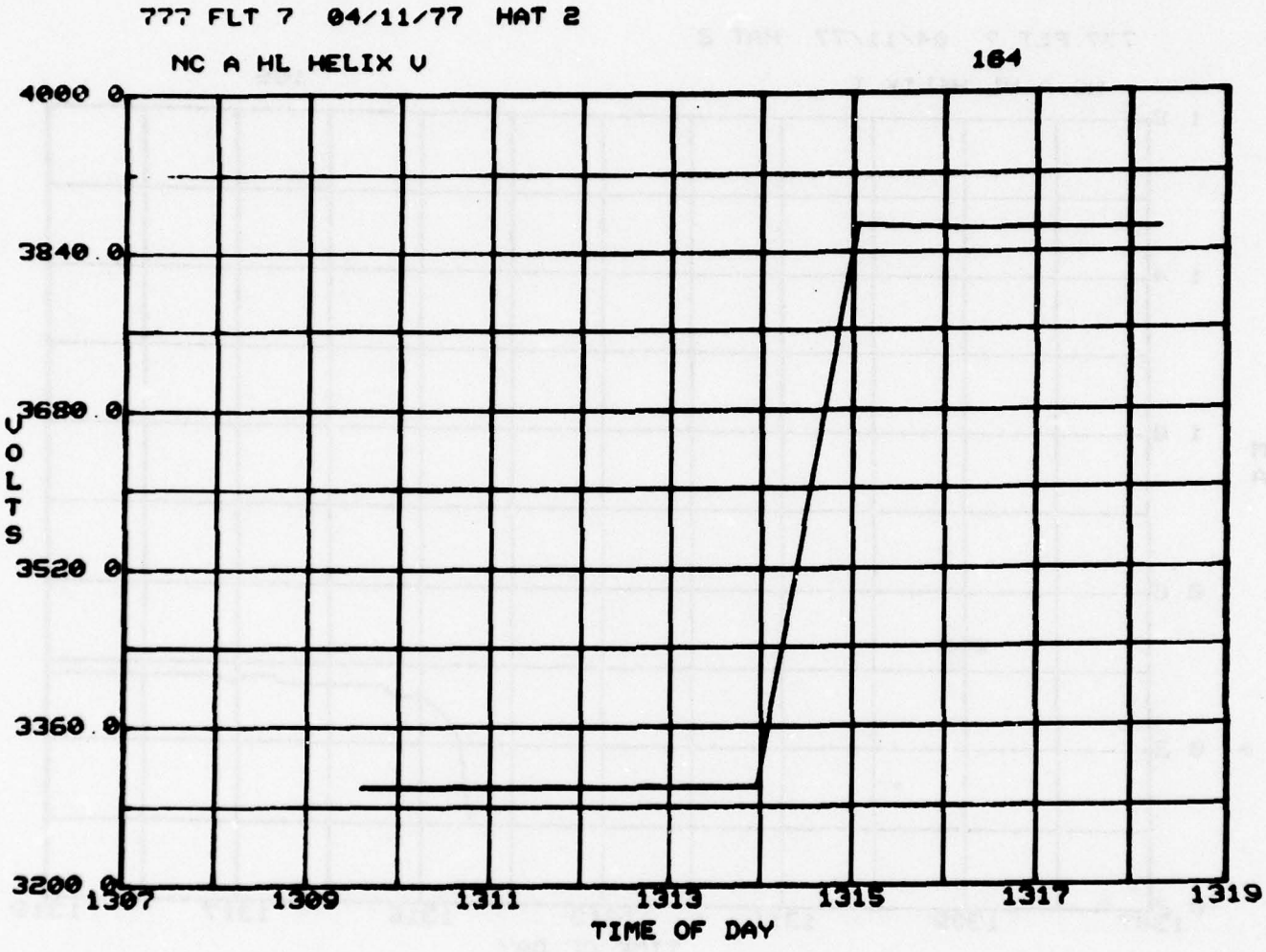
0 2
-0 2
M
A
1307
1309
1311
1313
1315
1317
1319
TIME OF DAY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NC A HL HELIX V
164
4000.0
3840.0
3680.0
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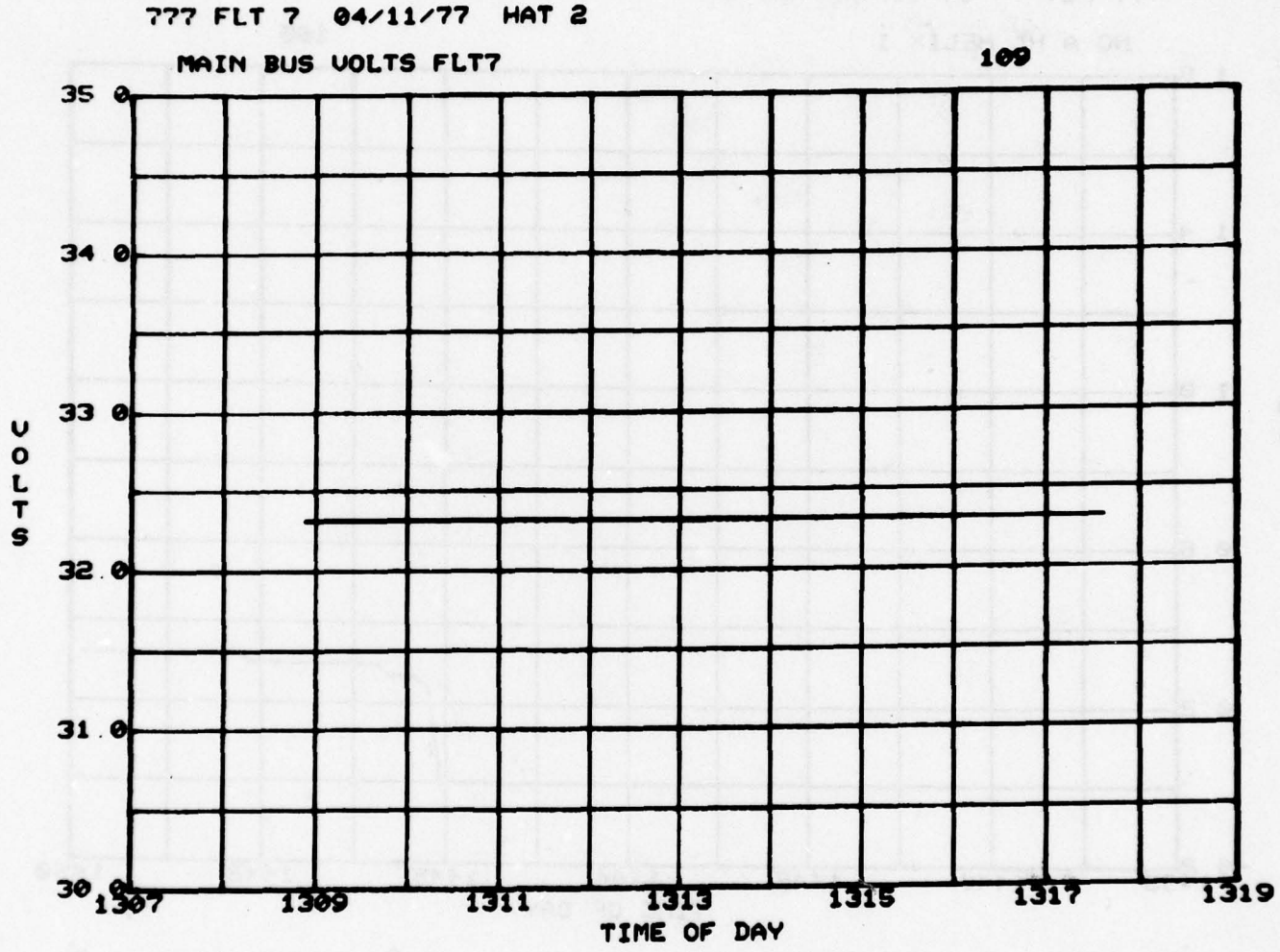
3360.0
3200.0
VOLTS
1307
1309
1311
1313
1315
1317
1319
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
MAIN BUS VOLTS FLT7
109
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31 0
30 0
VOLTS
1307
1309
1311
1313
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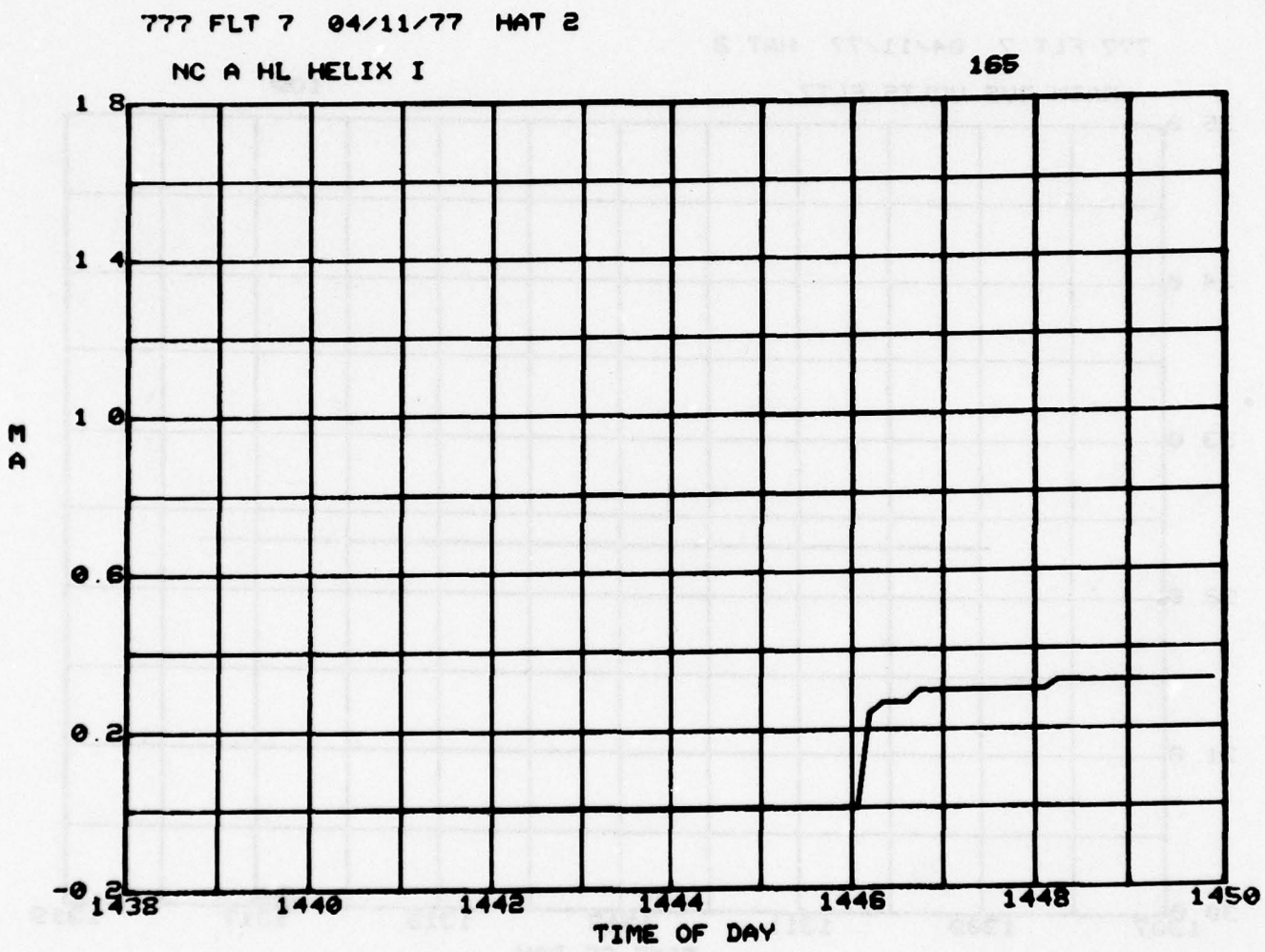
1317
1319
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC A HL HELIX I
165
1.8
1.4
1.0
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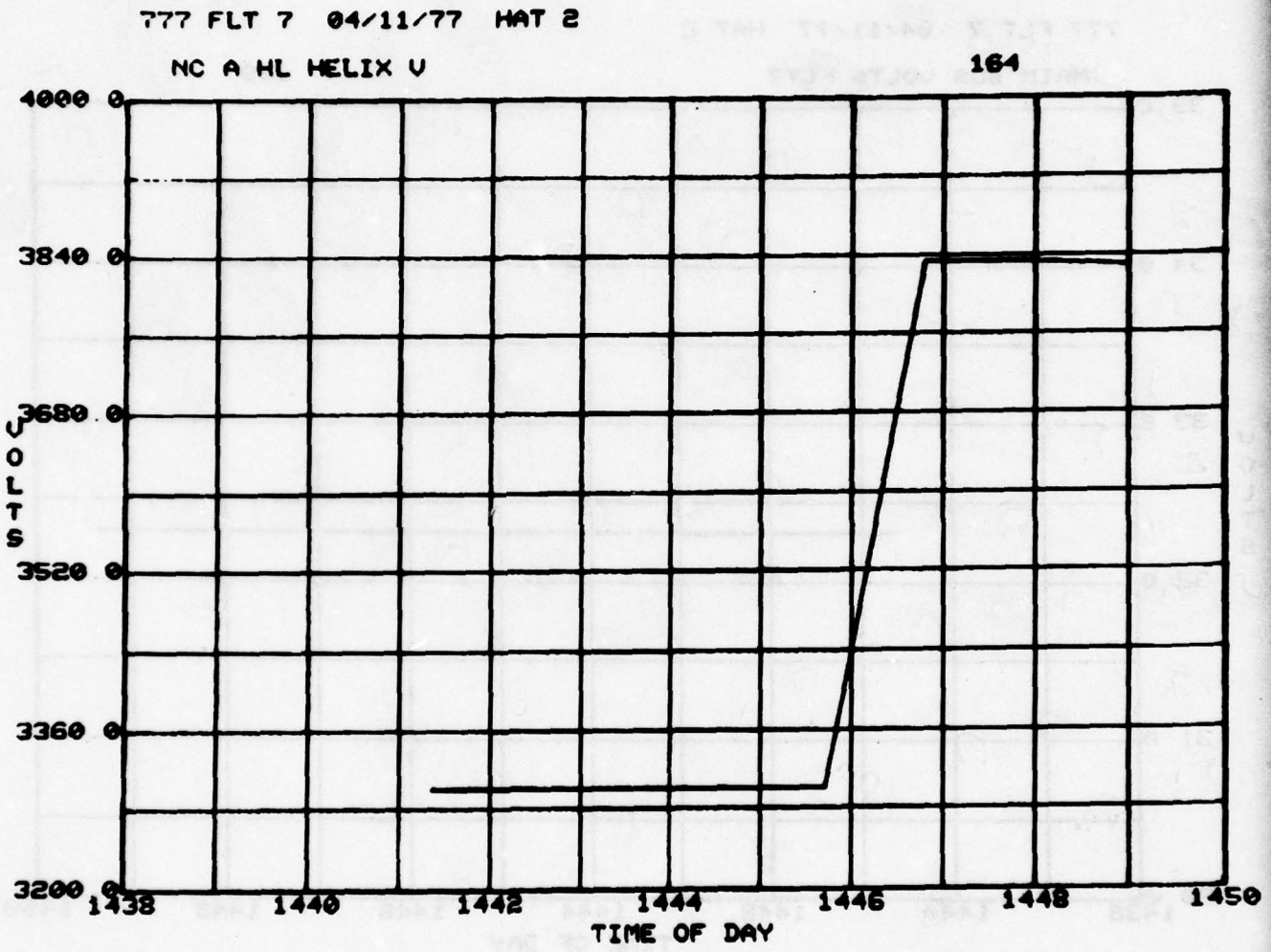
0.2
-0.2
MA
1438
1440
1442
1444
1446
1448
1450
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC A HL HELIX V
164
4000 0
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VOLTS
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1442
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1448
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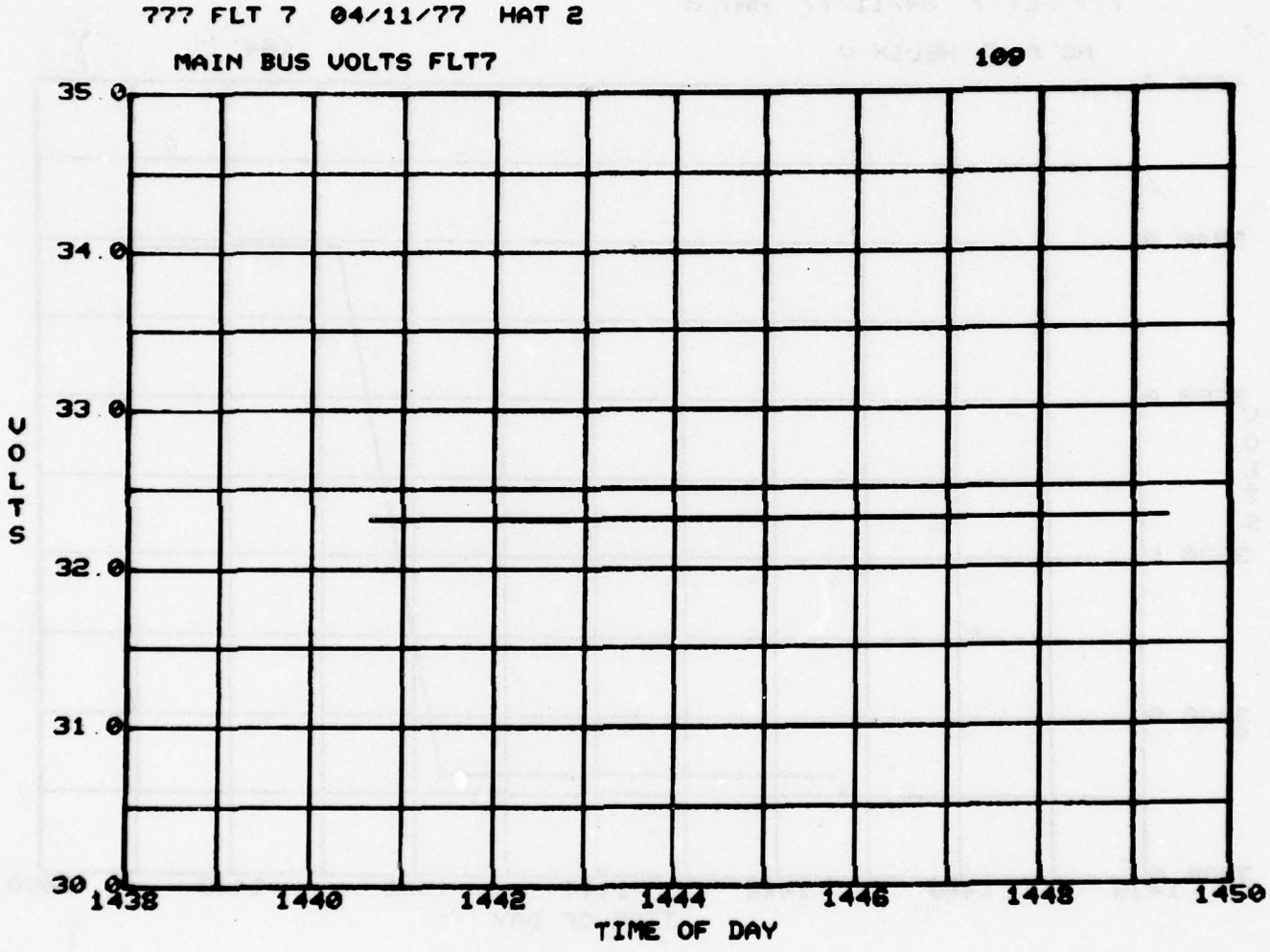
TIME OF DAY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MAIN BUS VOLTS FLT7
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33.0
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31.0
30.0
VOLTS
1438
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1442
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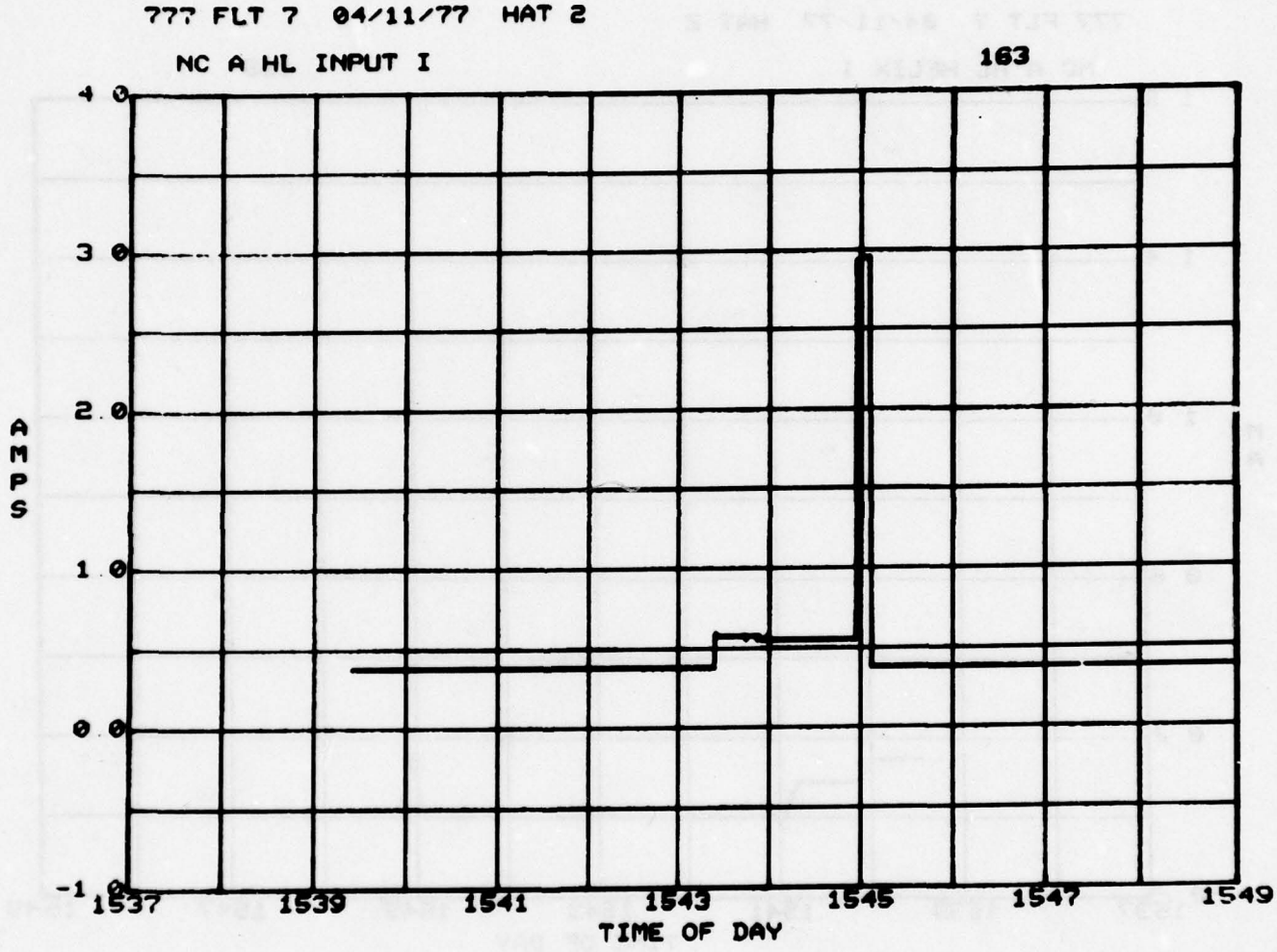
1448
1450
TIME OF DAY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163
4.0
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2.0
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-1.0
AMPS
1537
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1541
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1547
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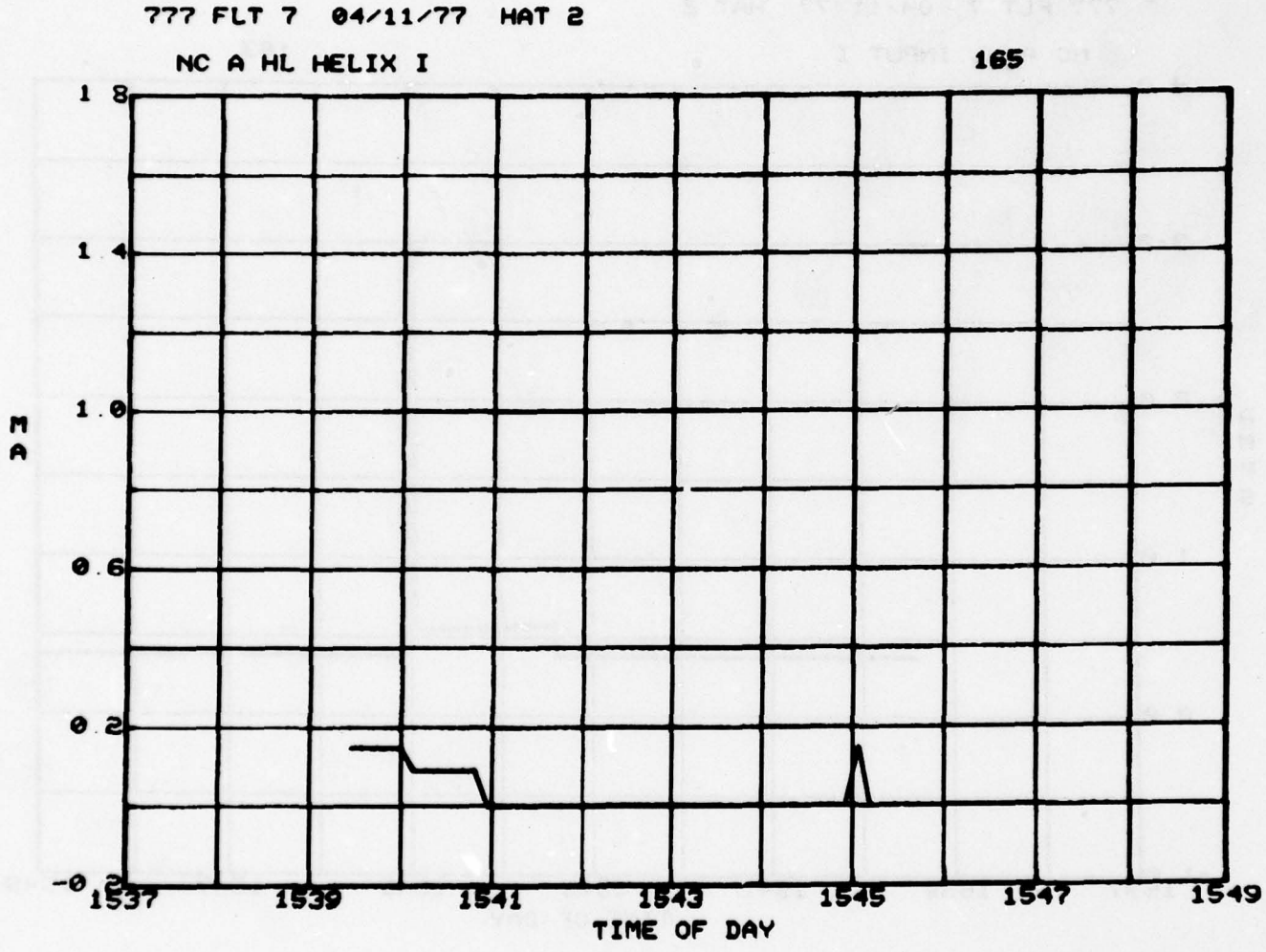
TIME OF DAY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NC A HL HELIX I
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1.8
1.4
1.0
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0.2
-0.2
MA
1537
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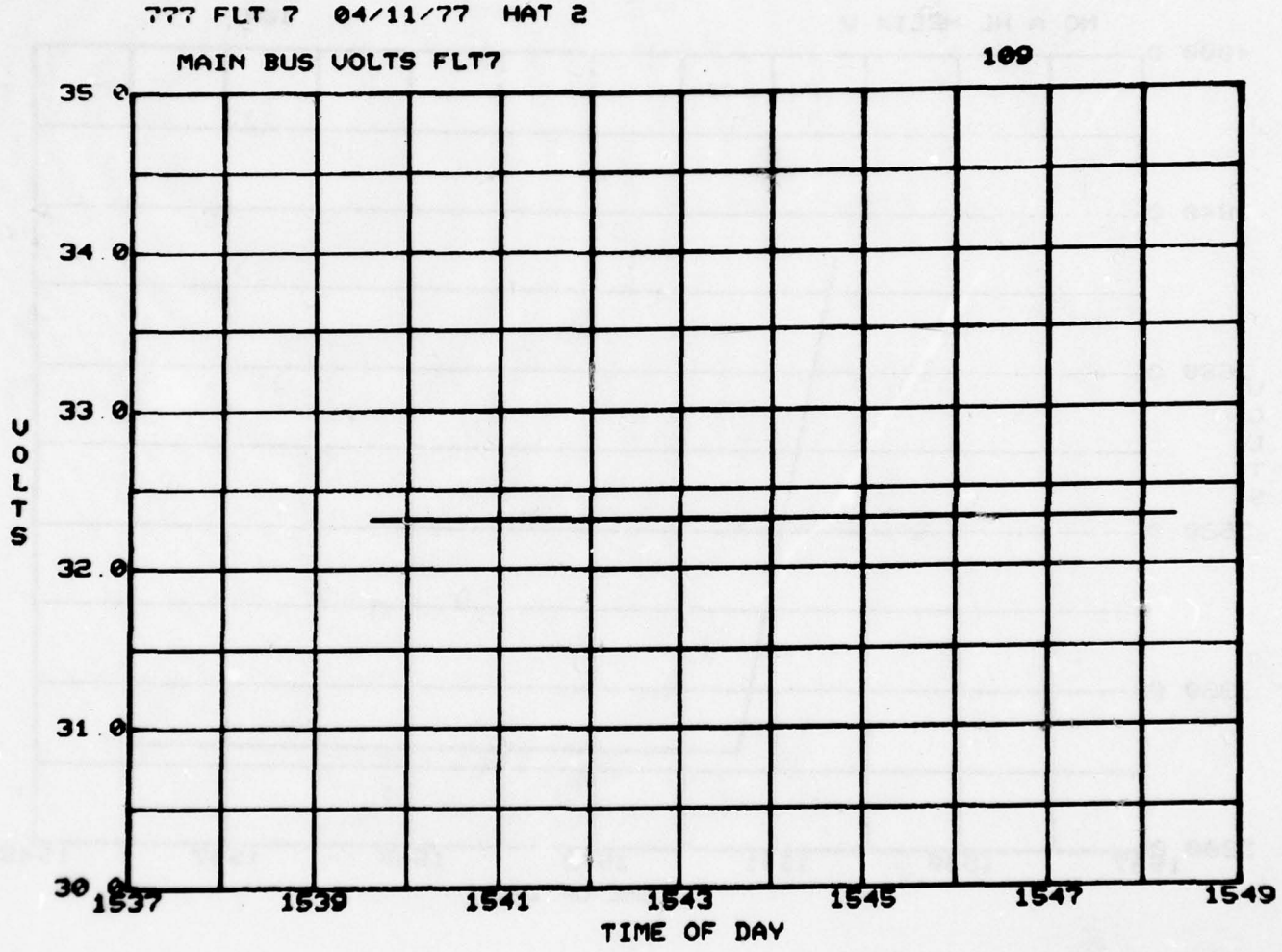
1547
1549
TIME OF DAY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MAIN BUS VOLTS FLT7
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VOLTS
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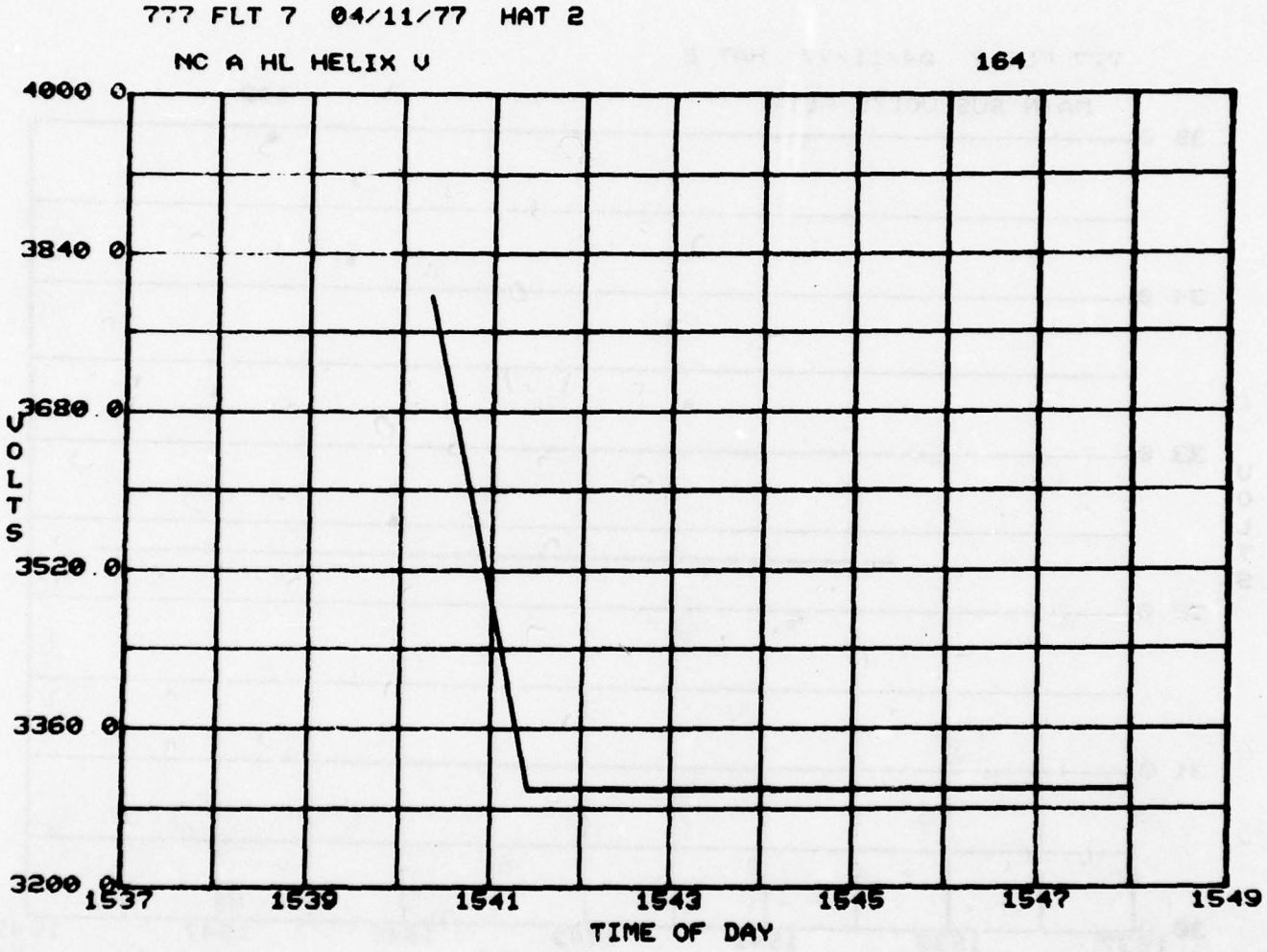
1549
TIME OF DAY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NC A HL HELIX V
164
4000 0
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3200 0
VOLTS
1537
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1541
1543
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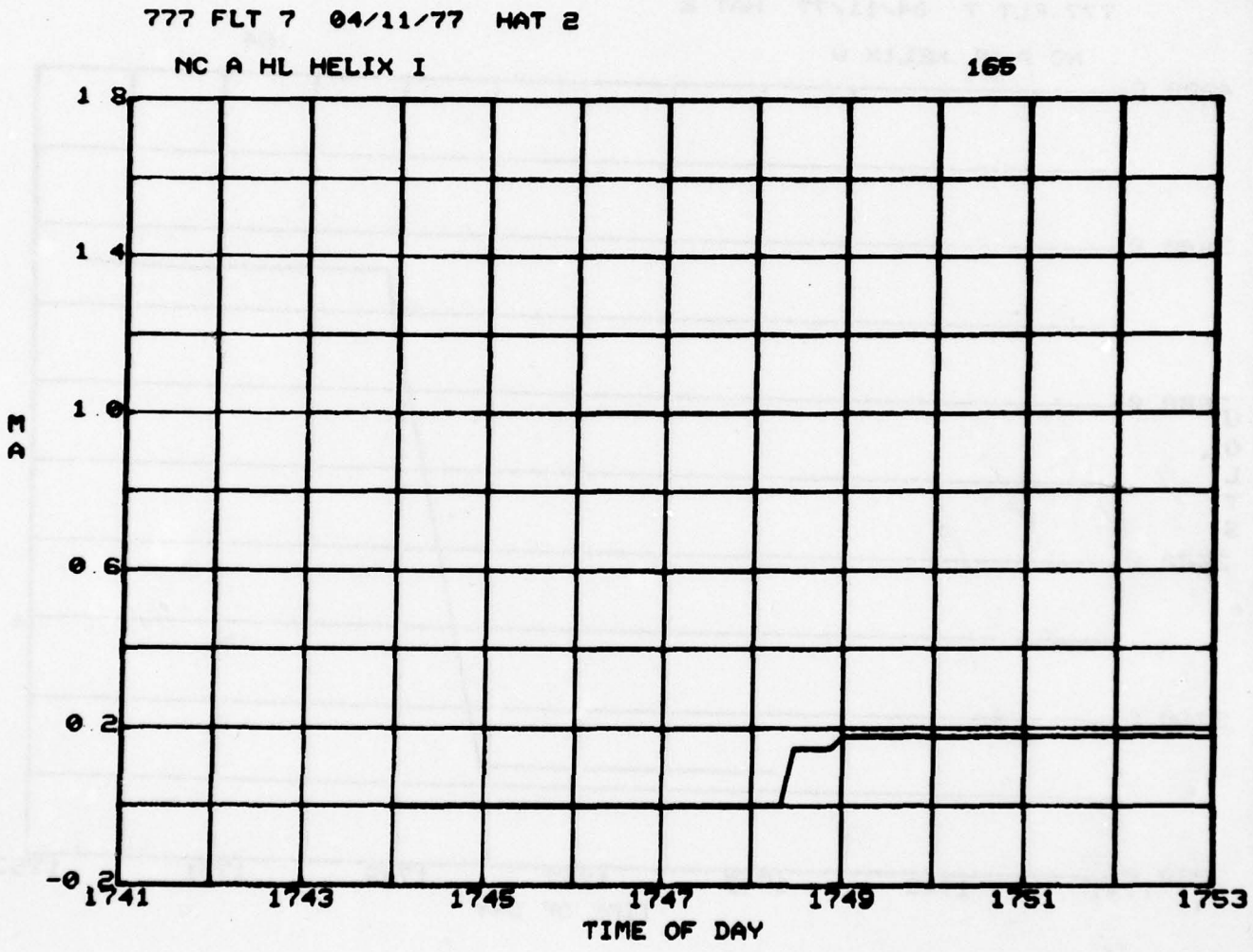
1547
1549
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC A HL HELIX I
165
1.8
1.4
1.0
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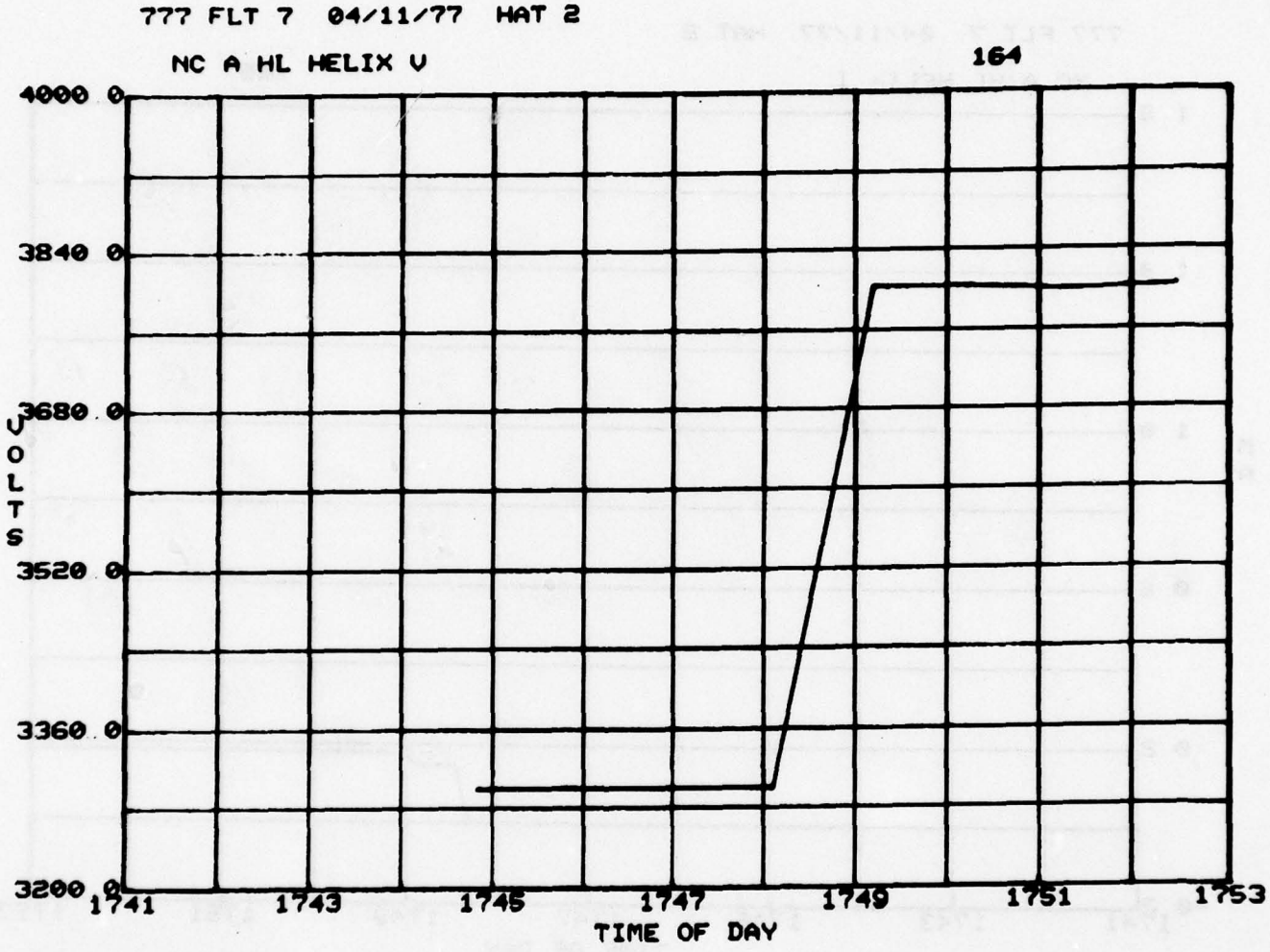
0.2
-0.2
MA
1741
1743
1745
1747
1749
1751
1753
TIME OF DAY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NC A HL HELIX V
164
4000 0
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3200 0
VOLTS
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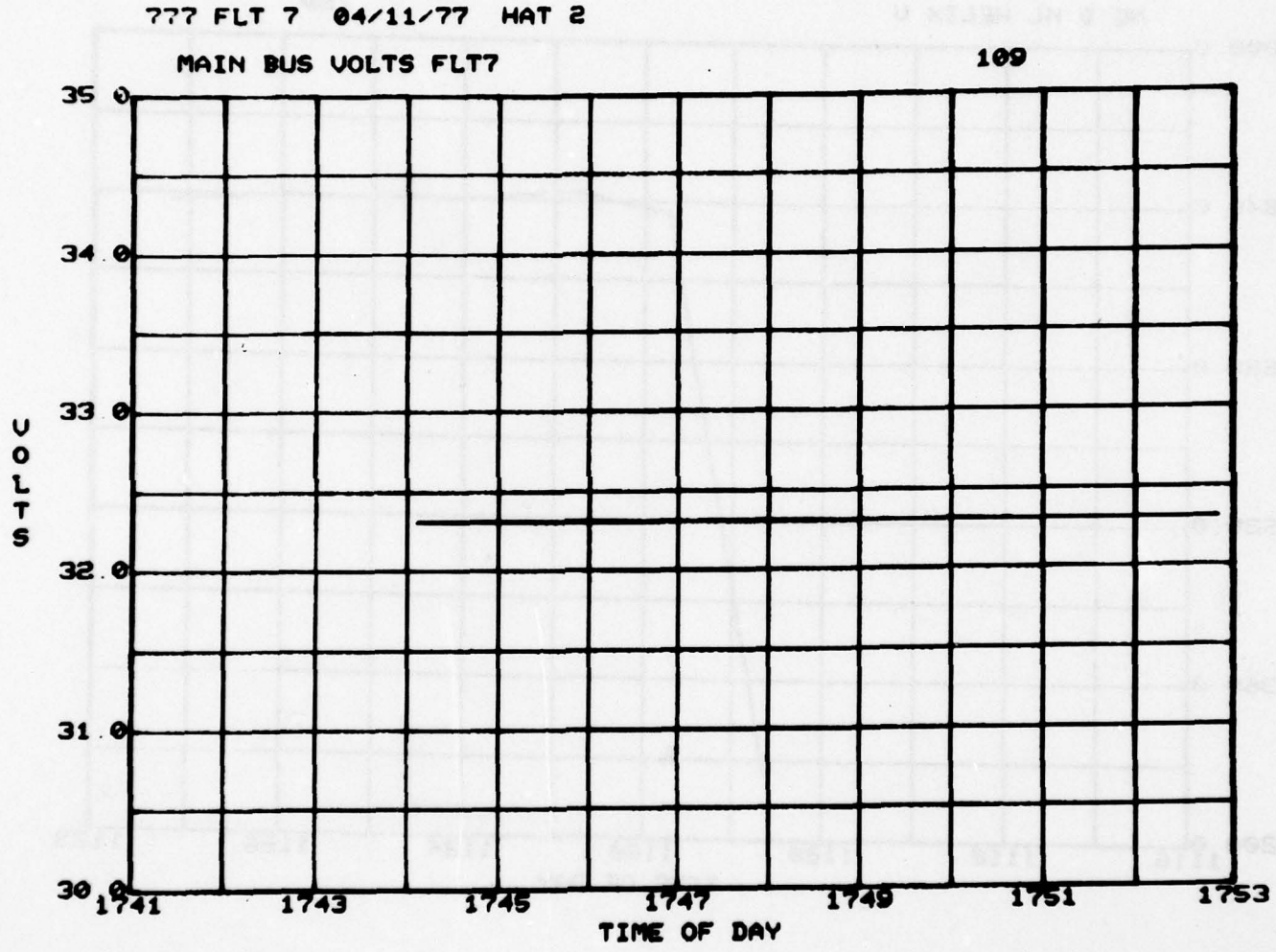
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
MAIN BUS VOLTS FLT7
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VOLTS
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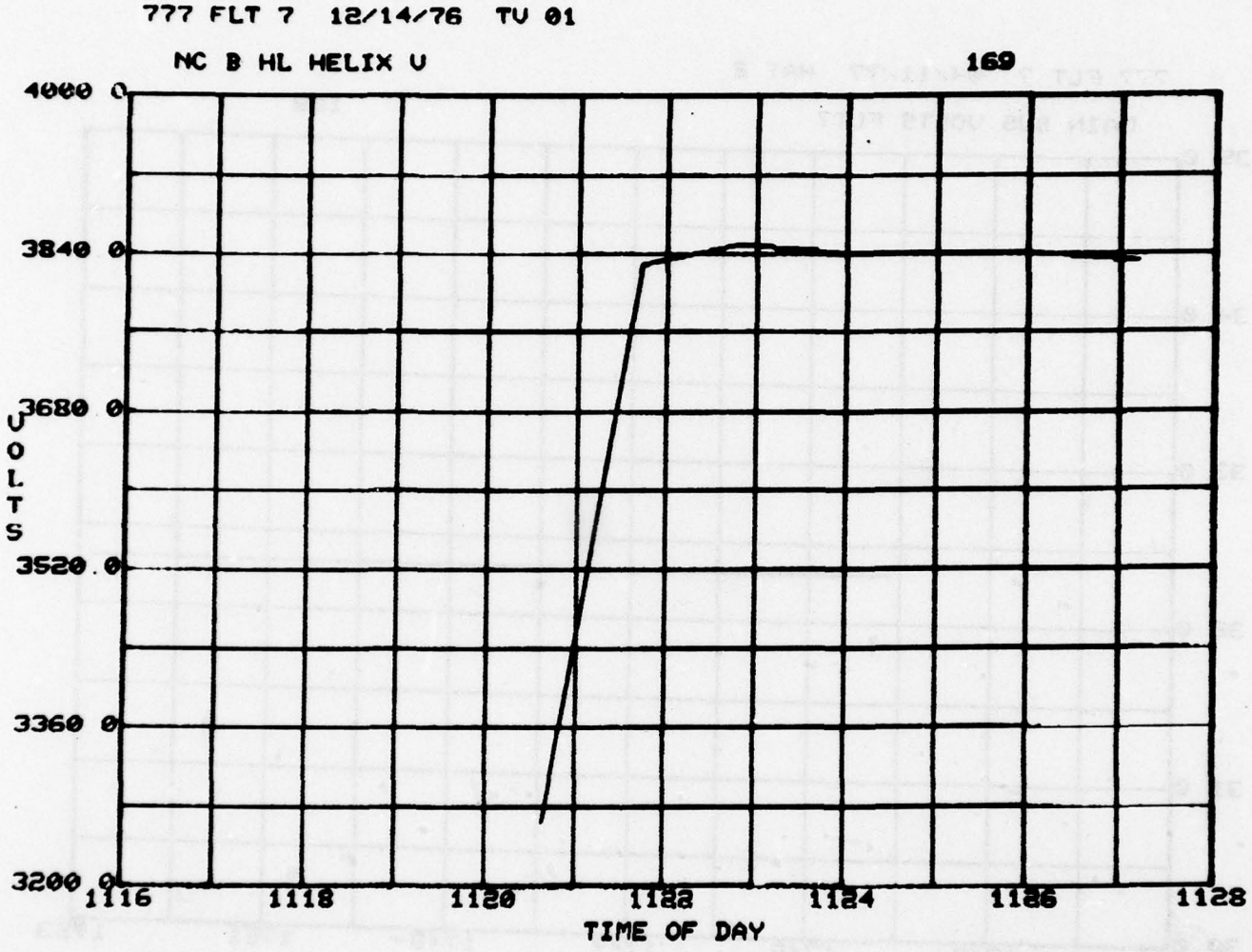
TIME OF DAY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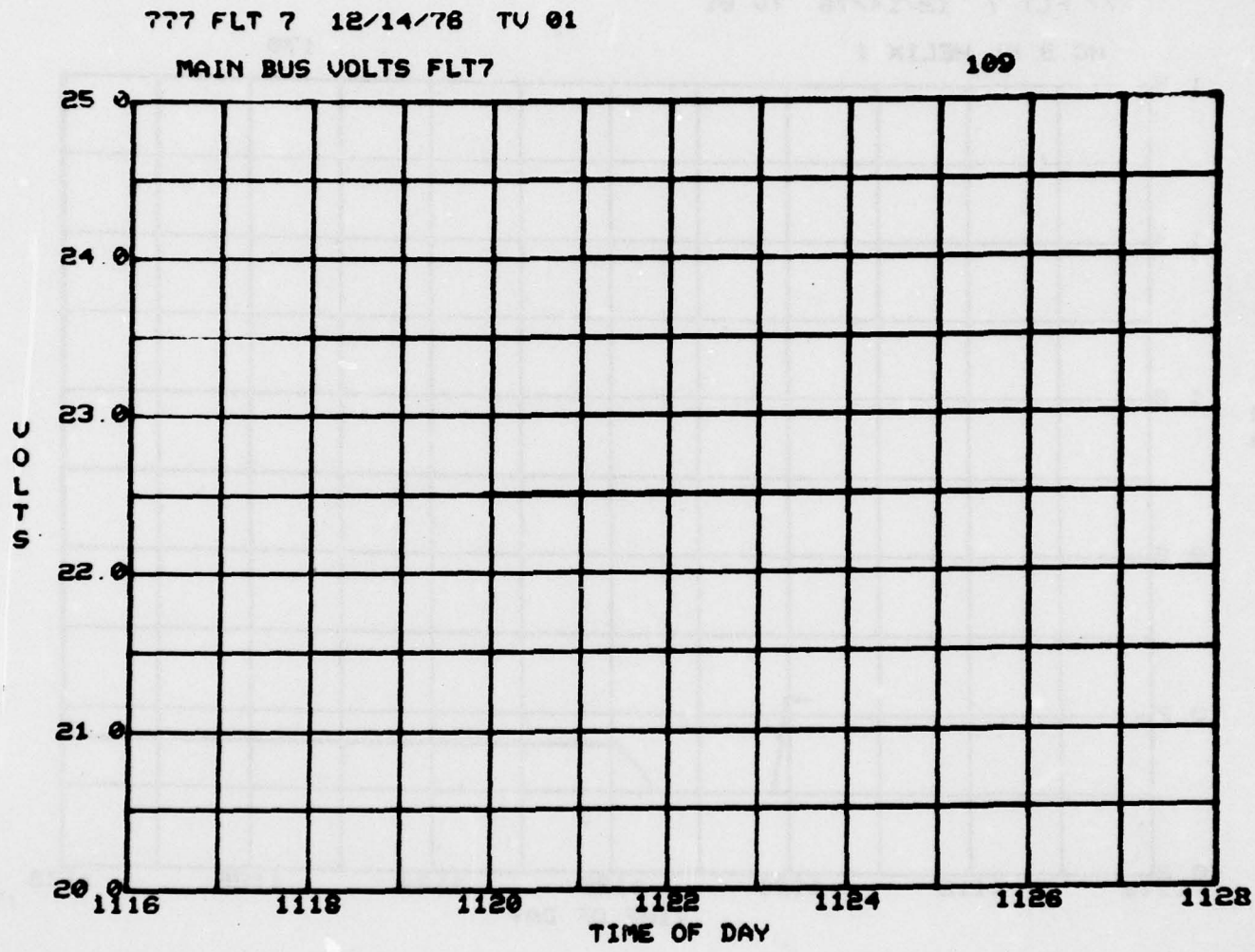
TIME OF DAY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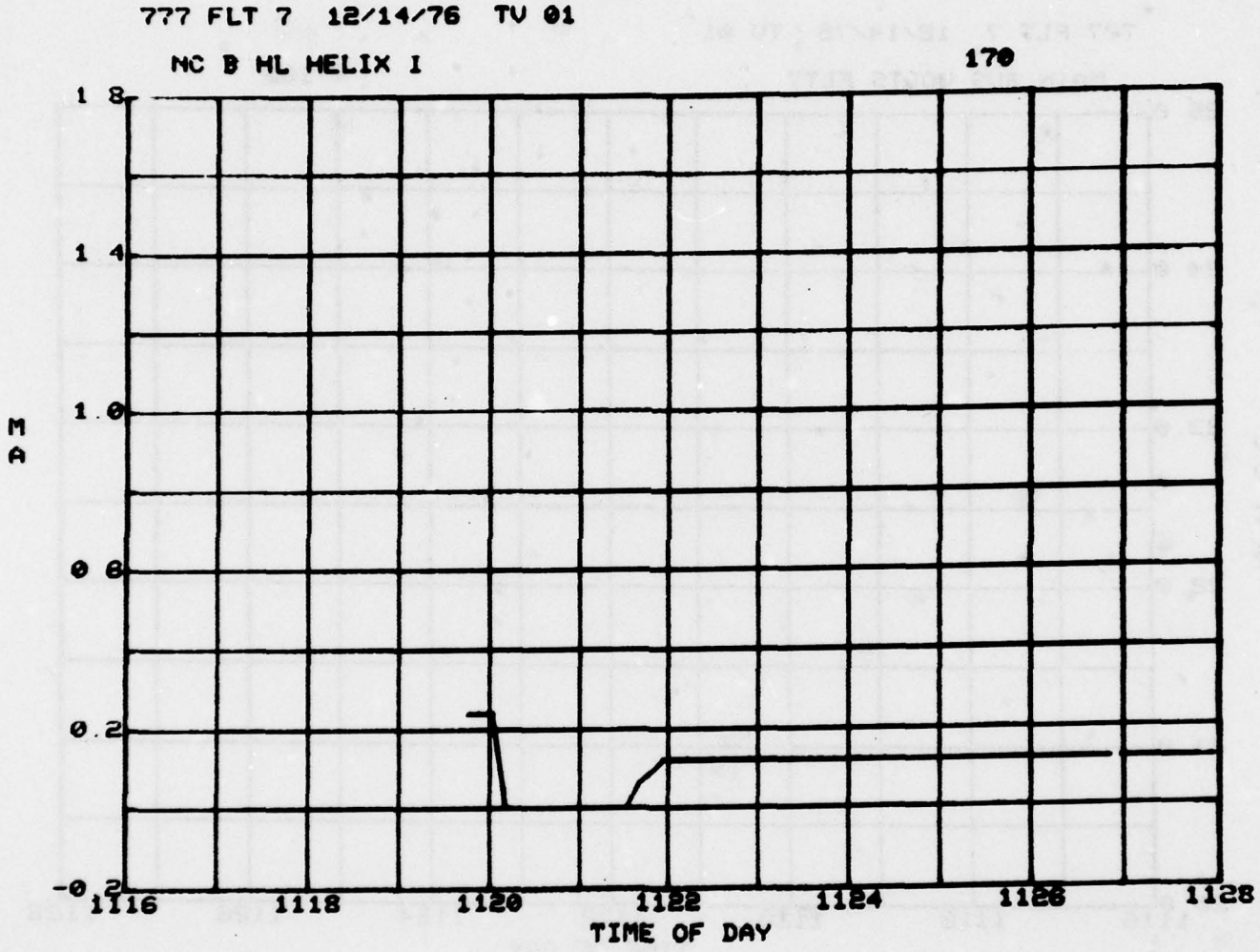
TIME OF DAY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NC B HL HELIX I
170
1 8
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0 2
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M
A
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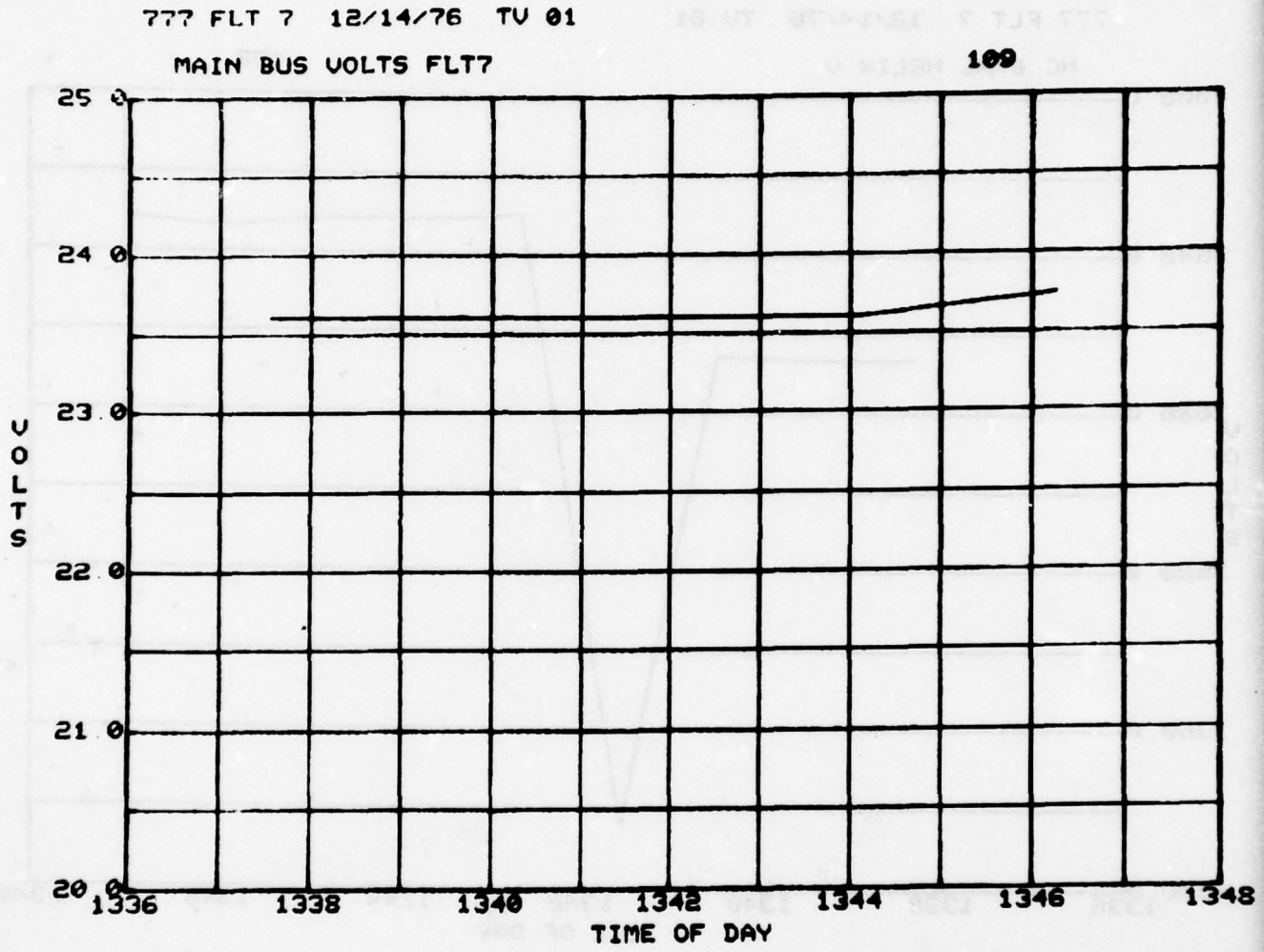
TIME OF DAY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109
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VOLTS
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1342
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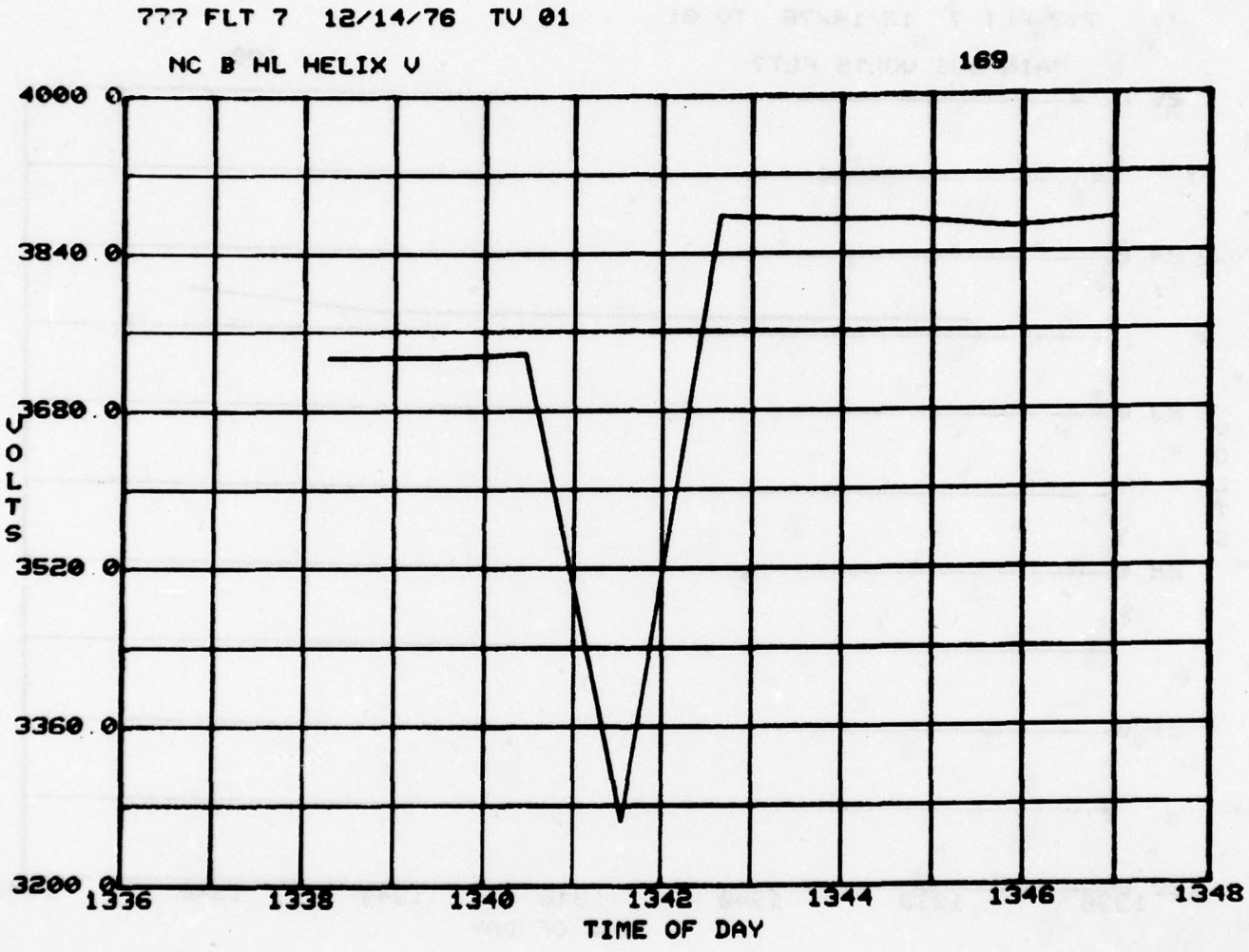
1346
1348
TIME OF DAY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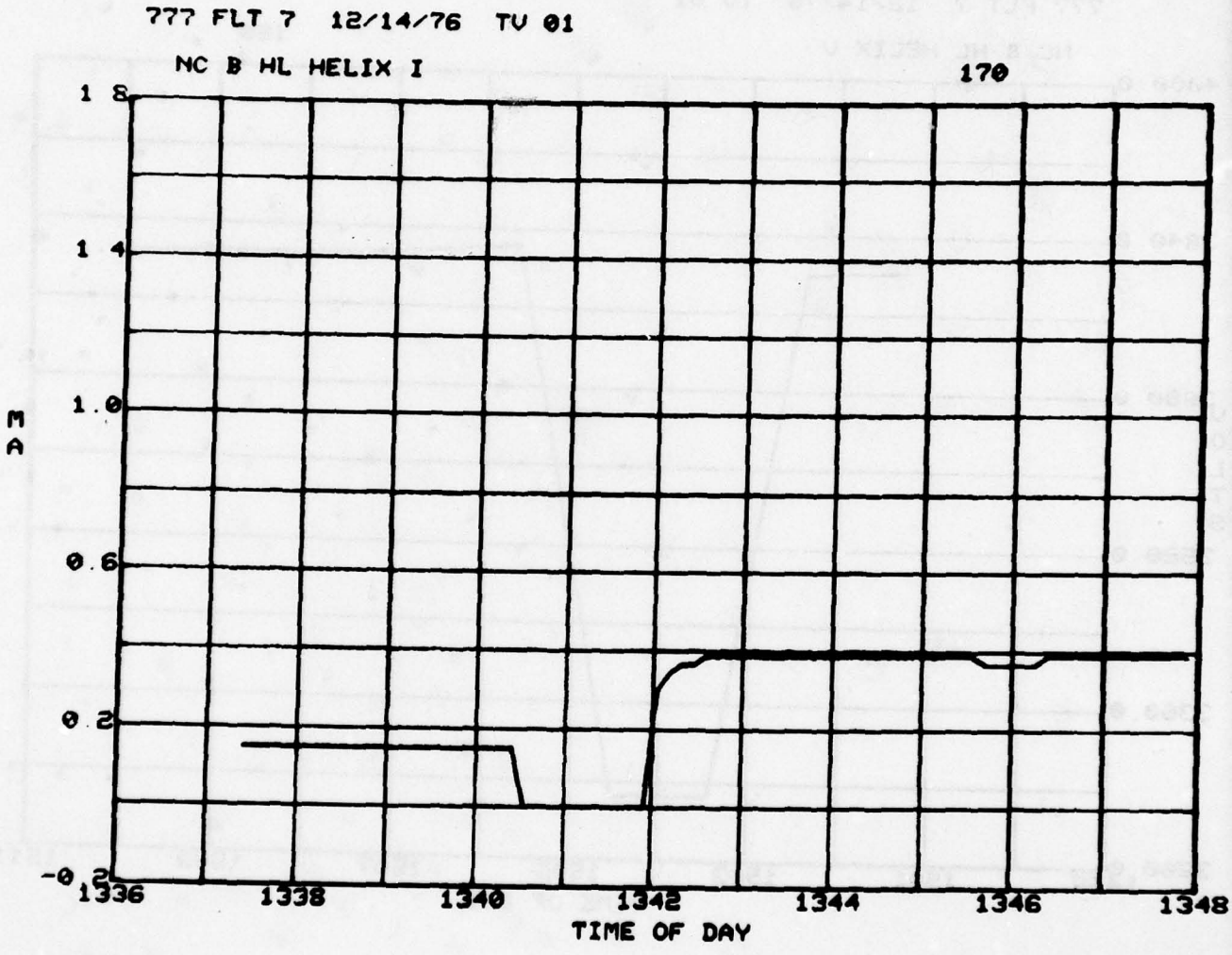
TIME OF DAY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NC B HL HELIX I
170
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0.2
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MA
1336
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1342
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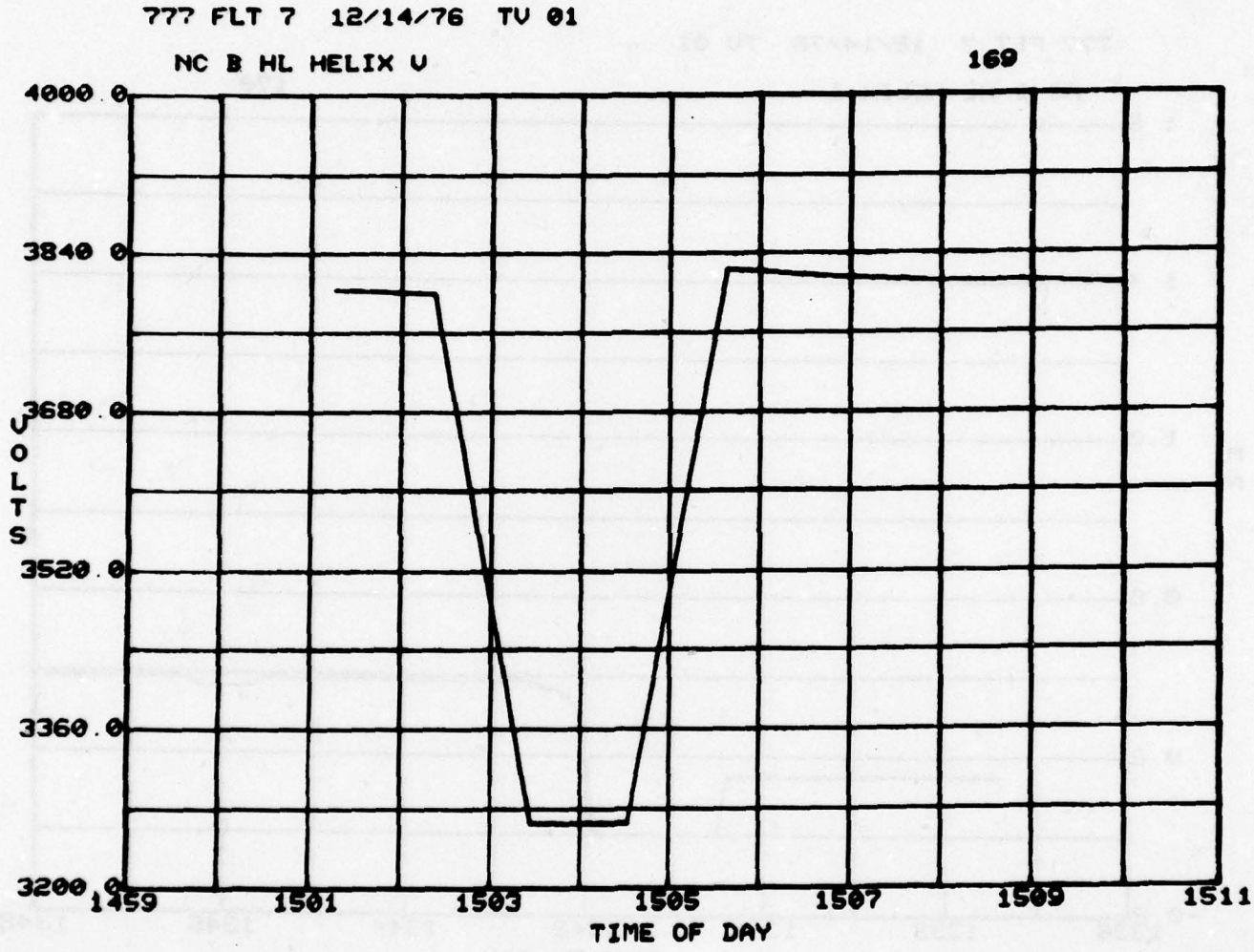
1348
TIME OF DAY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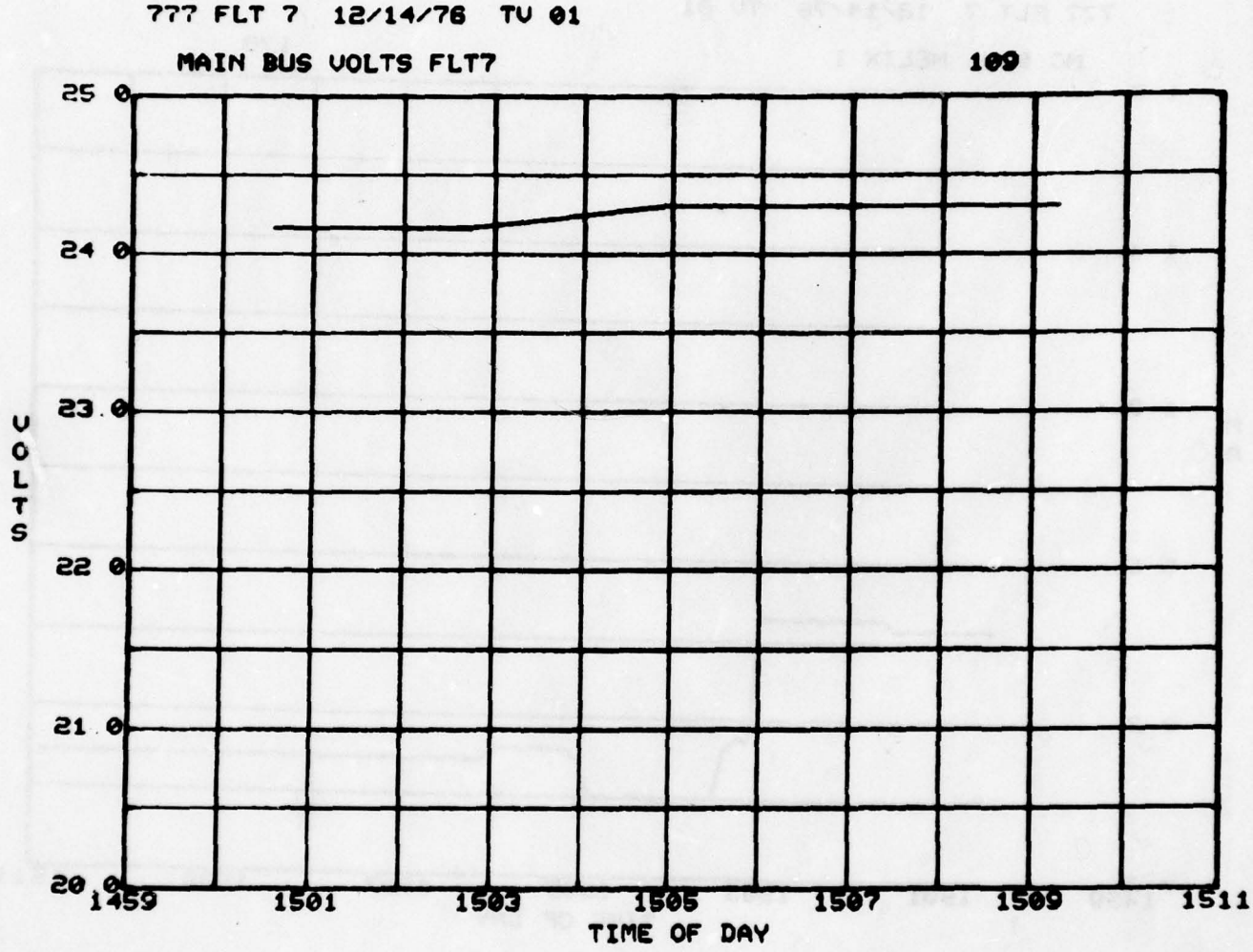
1511
TIME OF DAY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MAIN BUS VOLTS FLT7
109
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VOLTS
1459
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1503
1505
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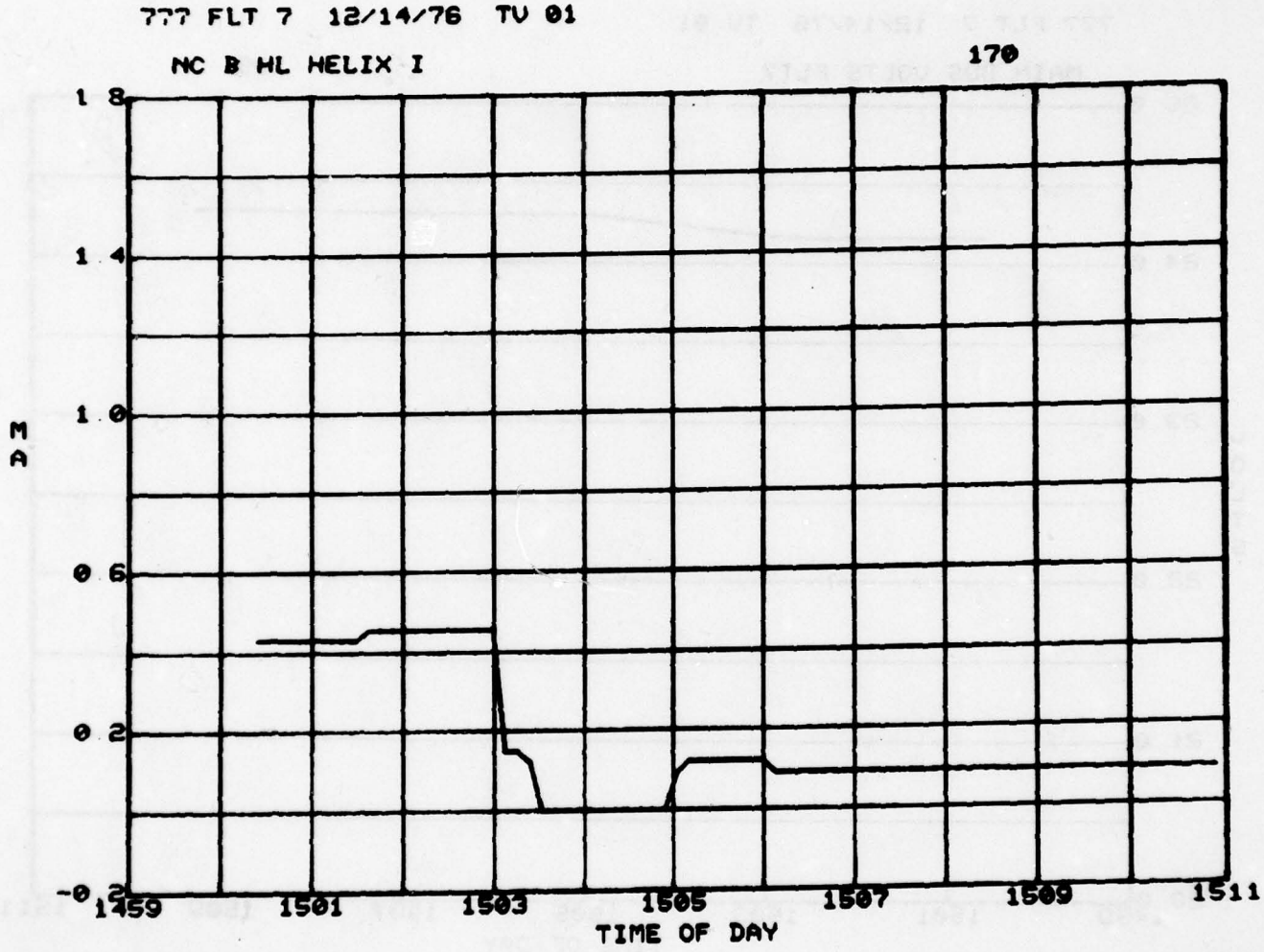
1509
1511
TIME OF DAY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1.4
1.0
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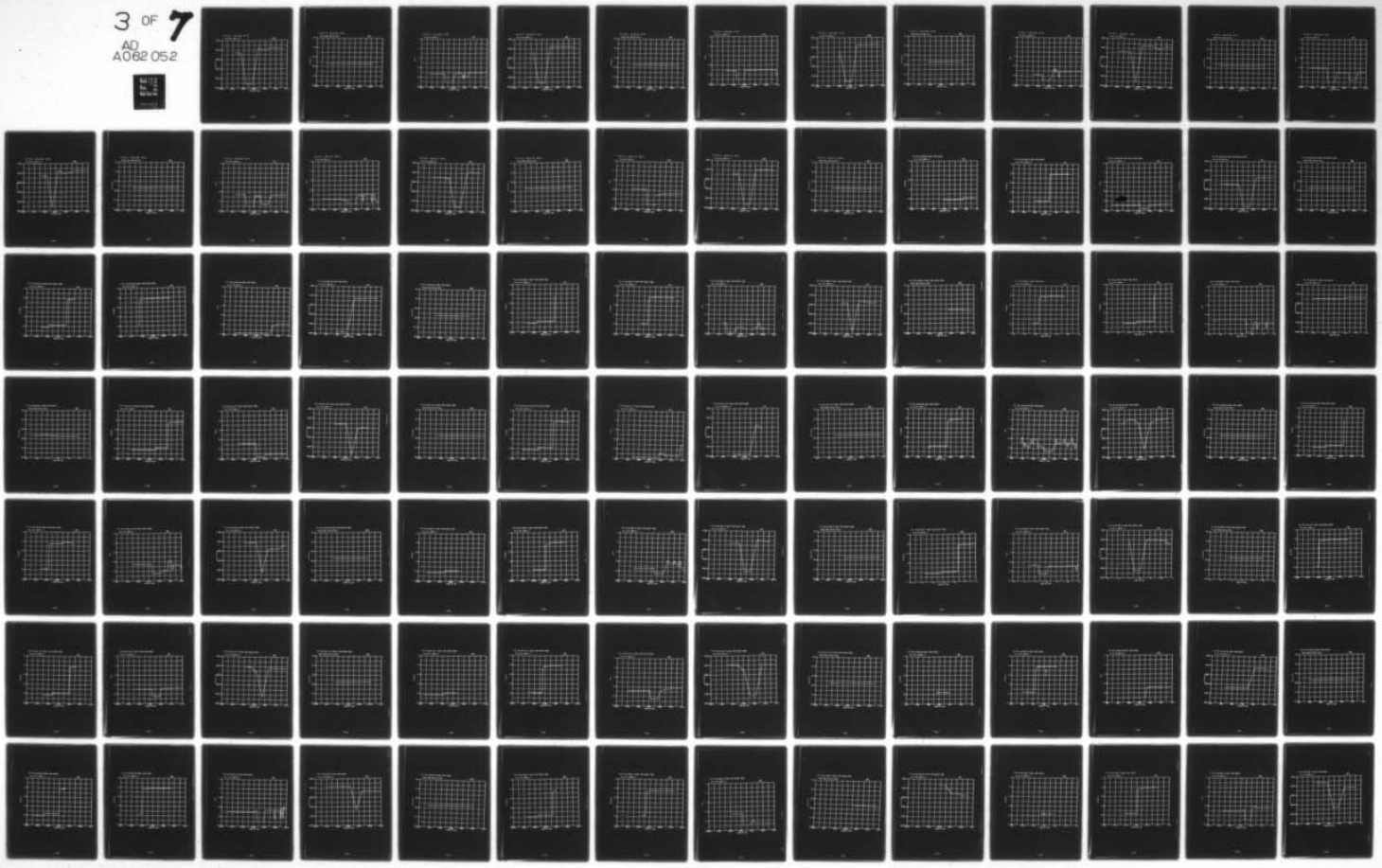
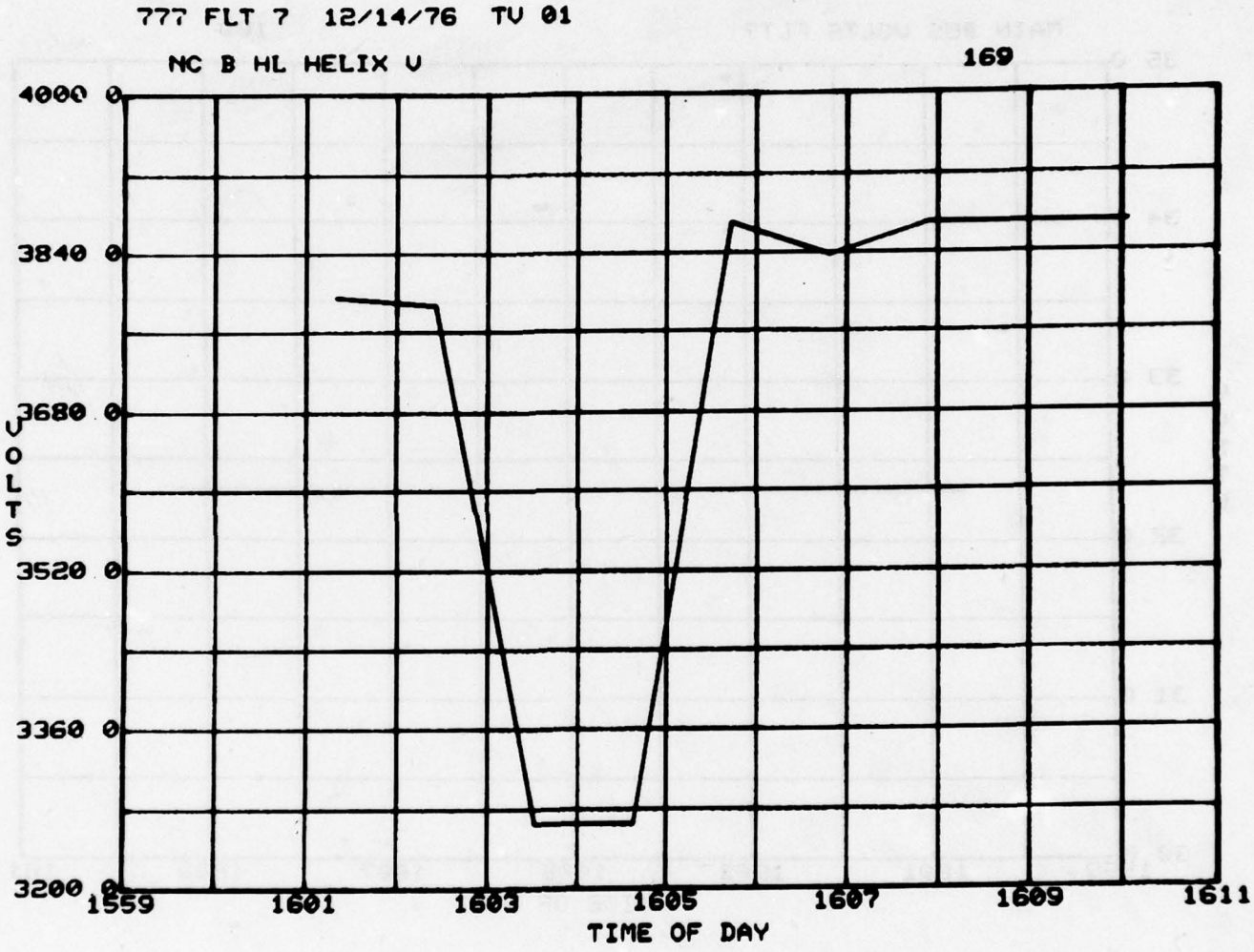
0.2
-0.2
MA
1459
1501
1503
1505
1507
1509
1511
TIME OF DAY

AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

3 OF 7
AD
A062 052

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VOLTS
1559
1601
1603
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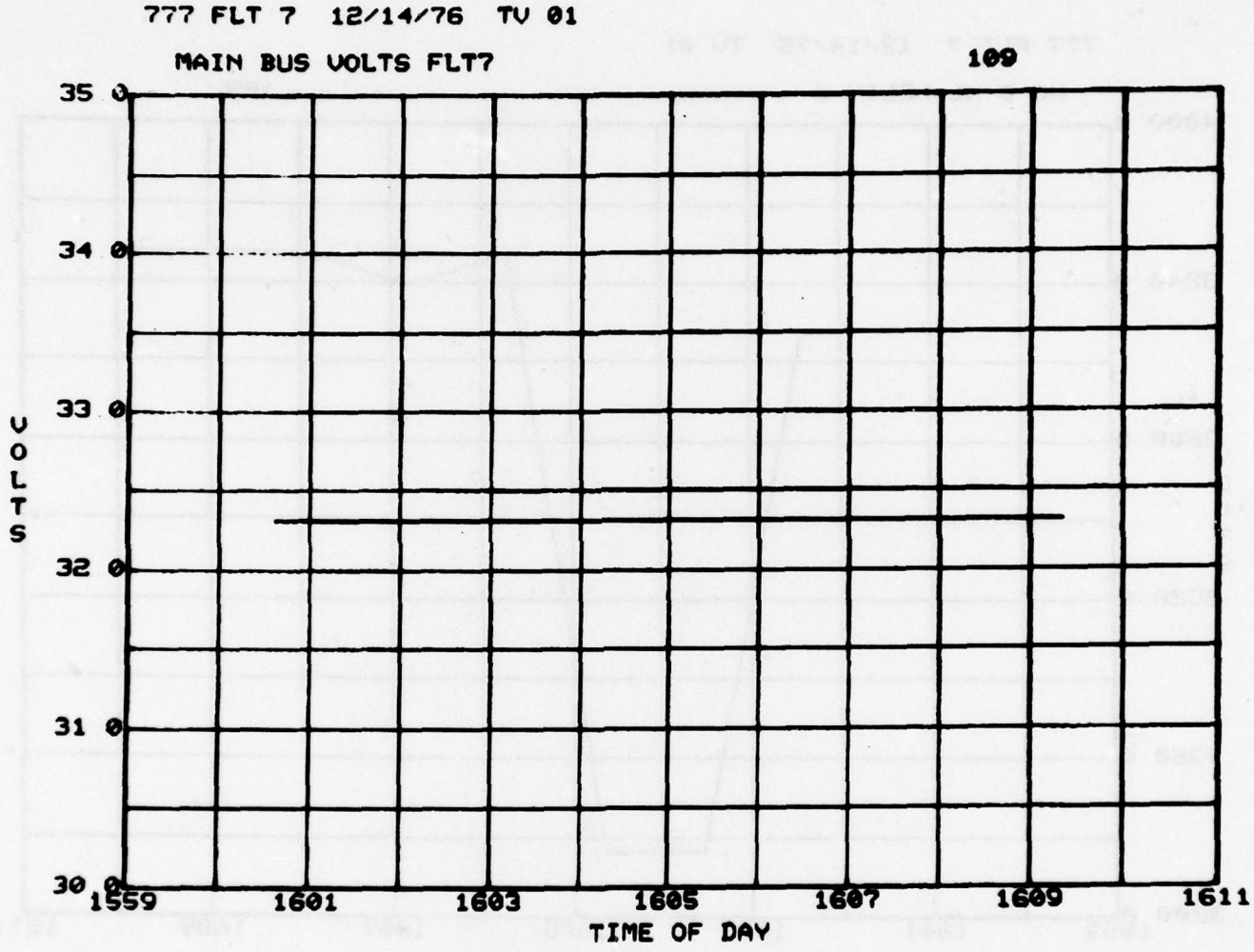
1609
1611
TIME OF DAY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31 0
30 0
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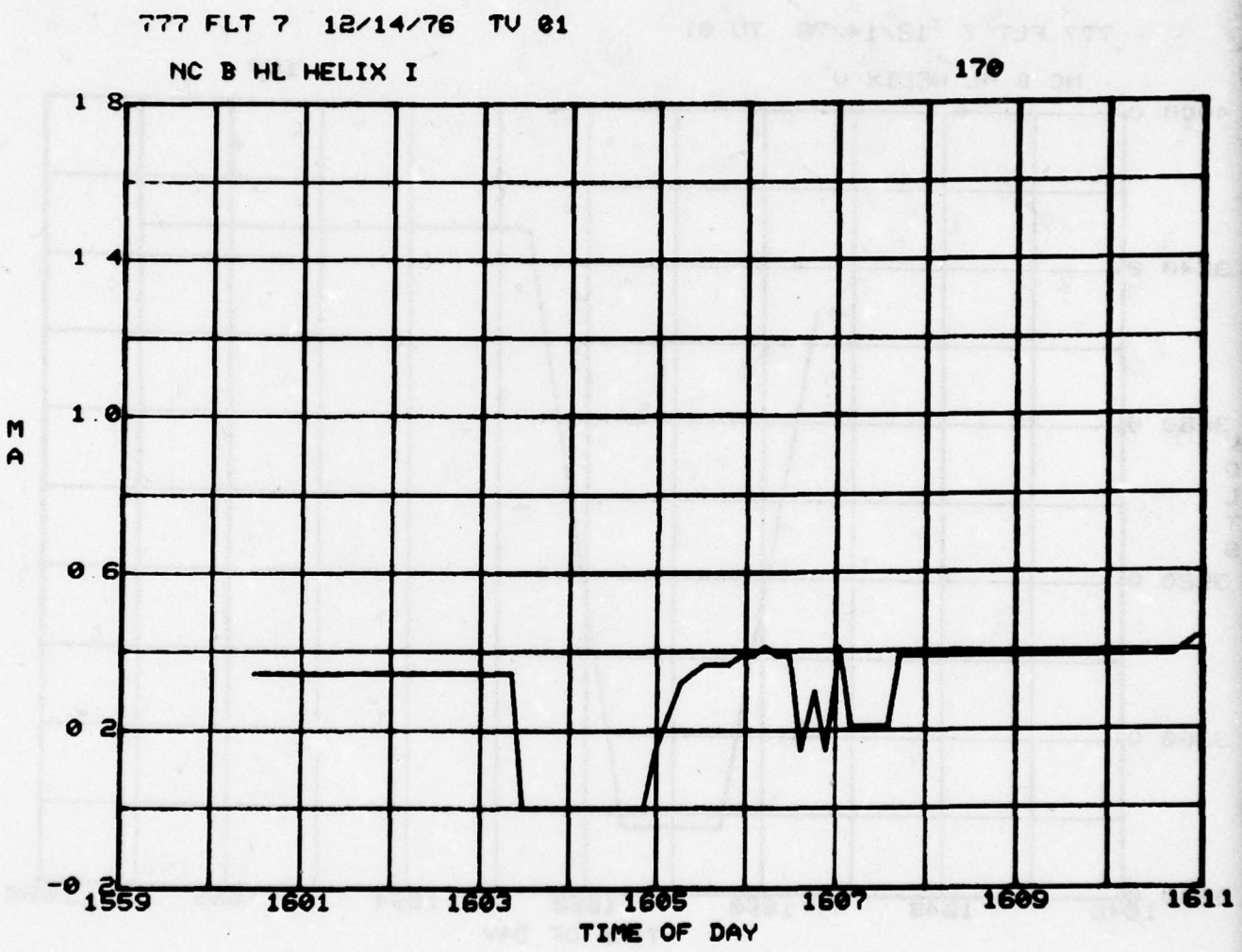
1601
1603
1605
1607
1609
1611
TIME OF DAY


777 FLT 7 12/14/76 TV 01
NC B HL HELIX I
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1 8
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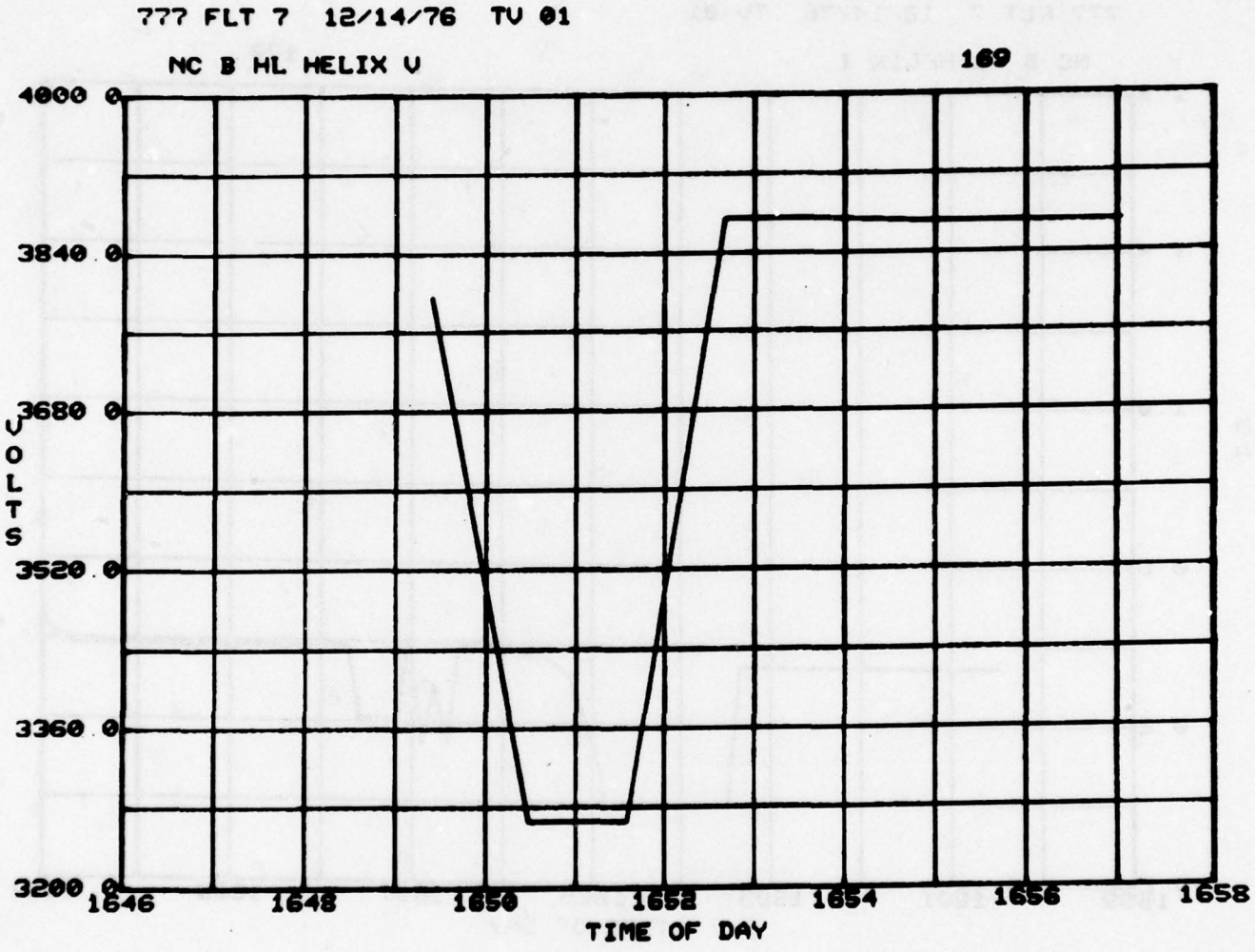
-0 2
M
A
1559
1601
1603
1605
1607
1609
1611
TIME OF DAY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VOLTS
1646
1648
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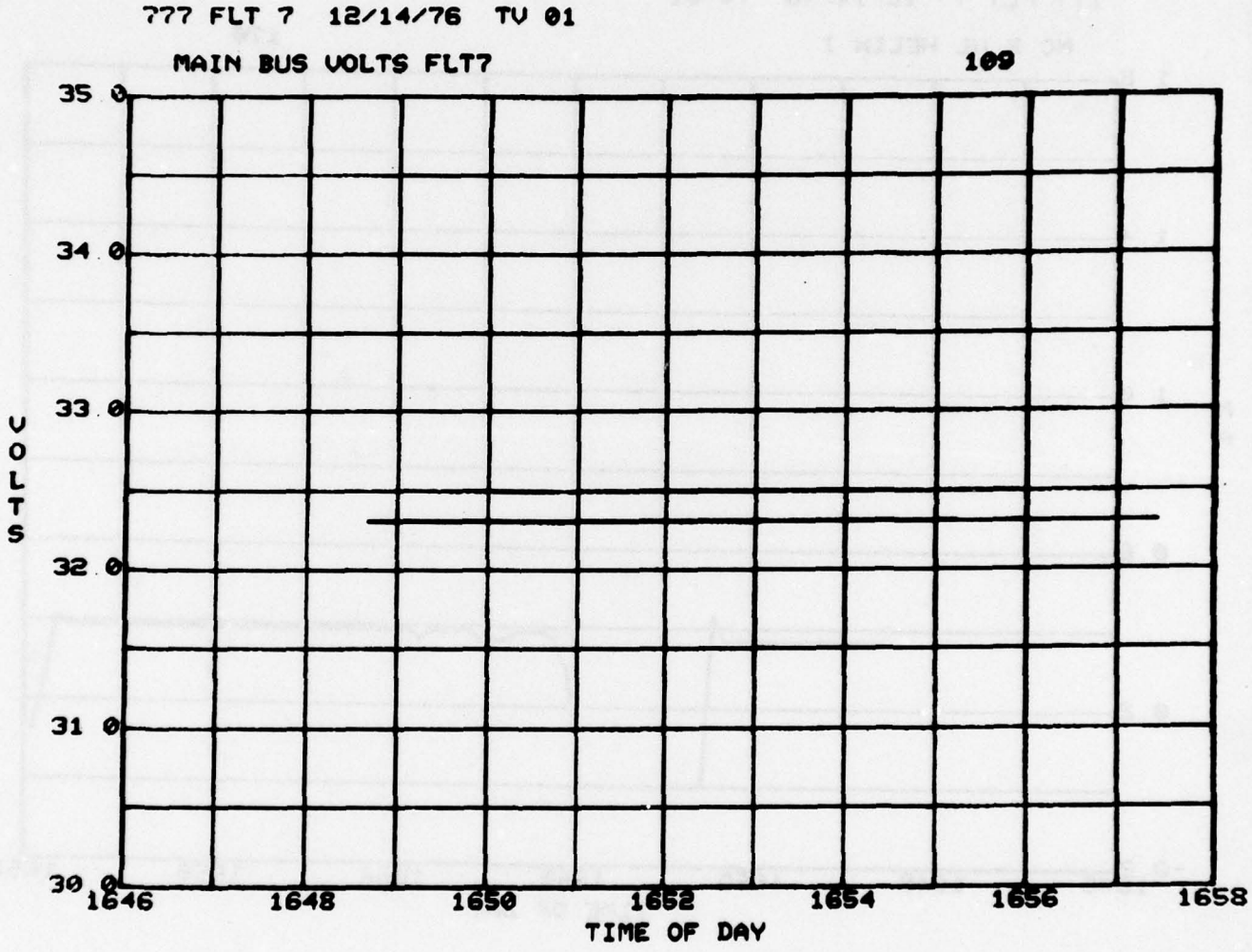
1652
1654
1656
1658
TIME OF DAY


777 FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
109
35.0
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33.0
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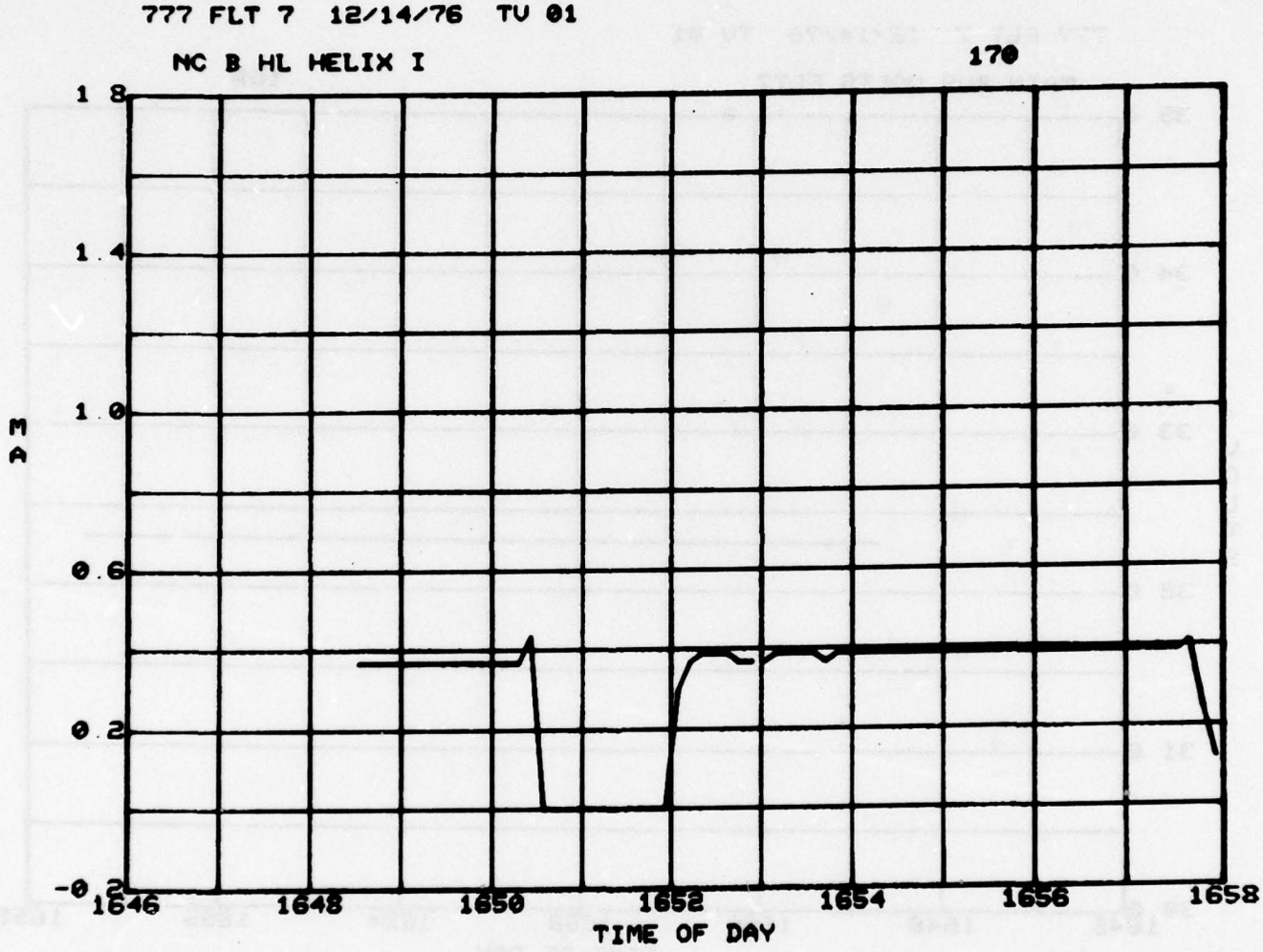
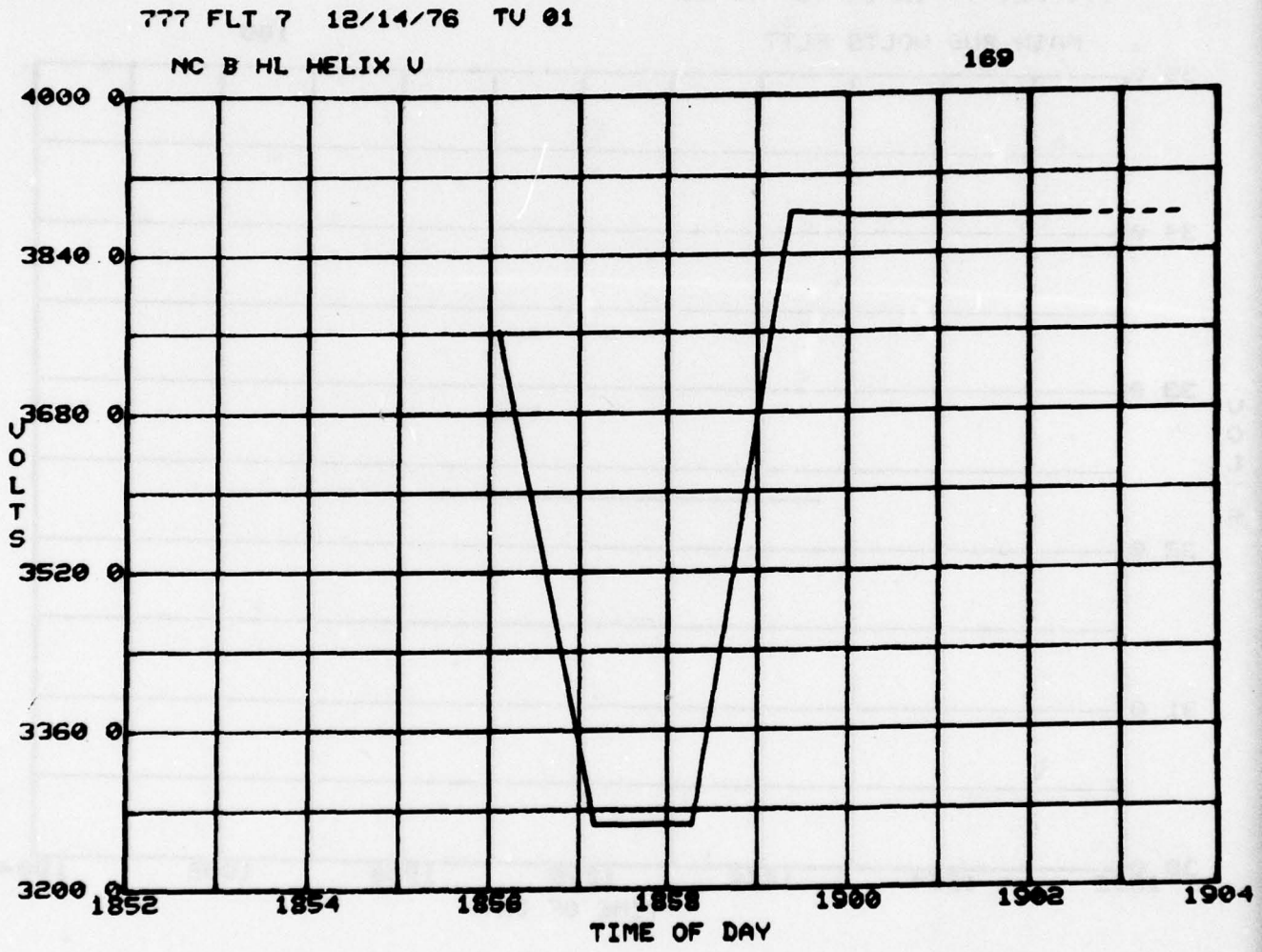
31.0
30.0
VOLTS
1646
1648
1650
1652
1654
1656
1658
TIME OF DAY


777 FLT 7 12/14/76 TU 01
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1646
1648
1650
1652
1654
1656
1658
TIME OF DAY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NC B HL HELIX V
169
4000 0
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3680 0
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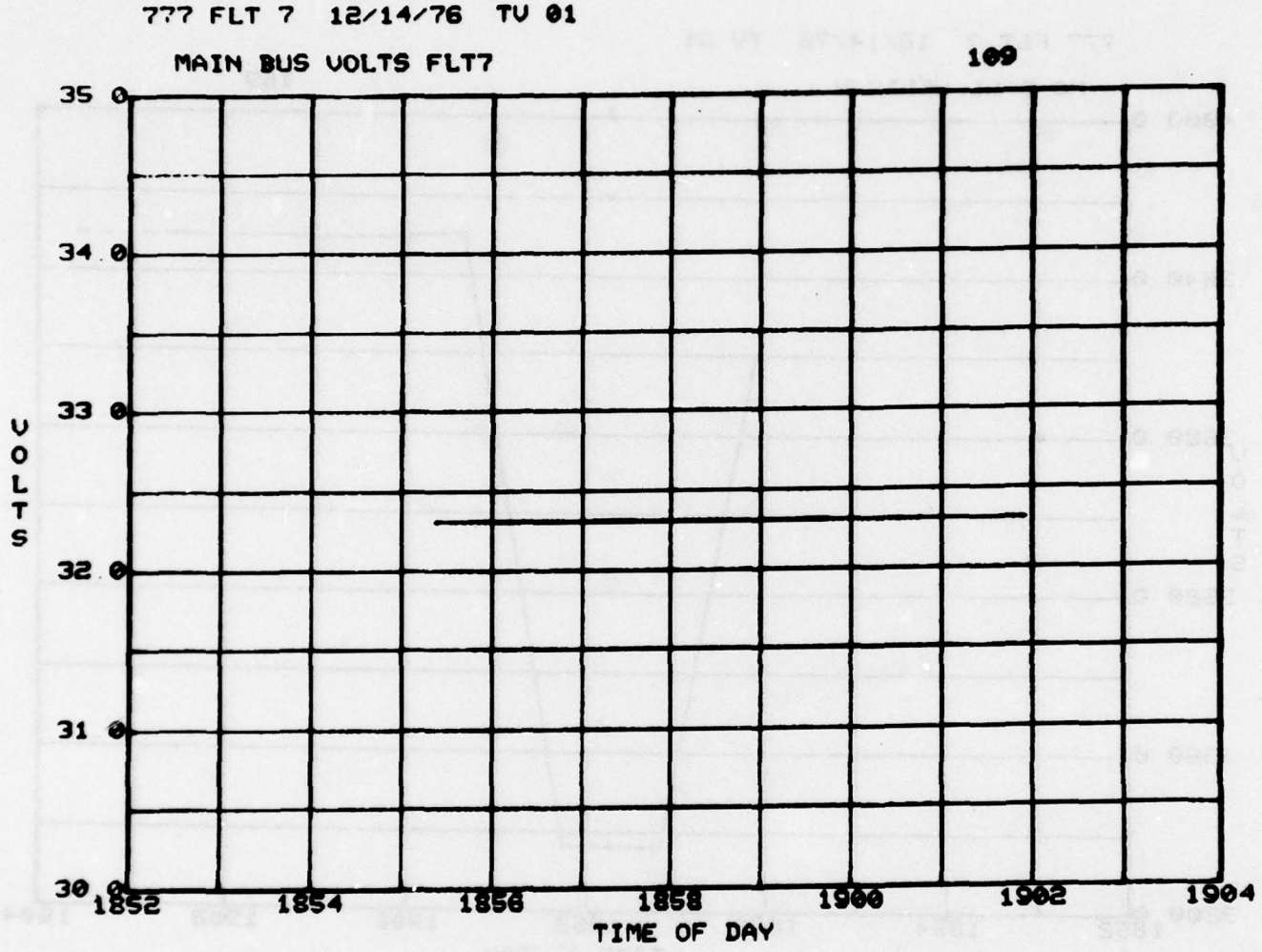
3360 0
3200 0
VOLTS
1852
1854
1856
1858
1900
1902
1904
TIME OF DAY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MAIN BUS VOLTS FLT7
109
35.0
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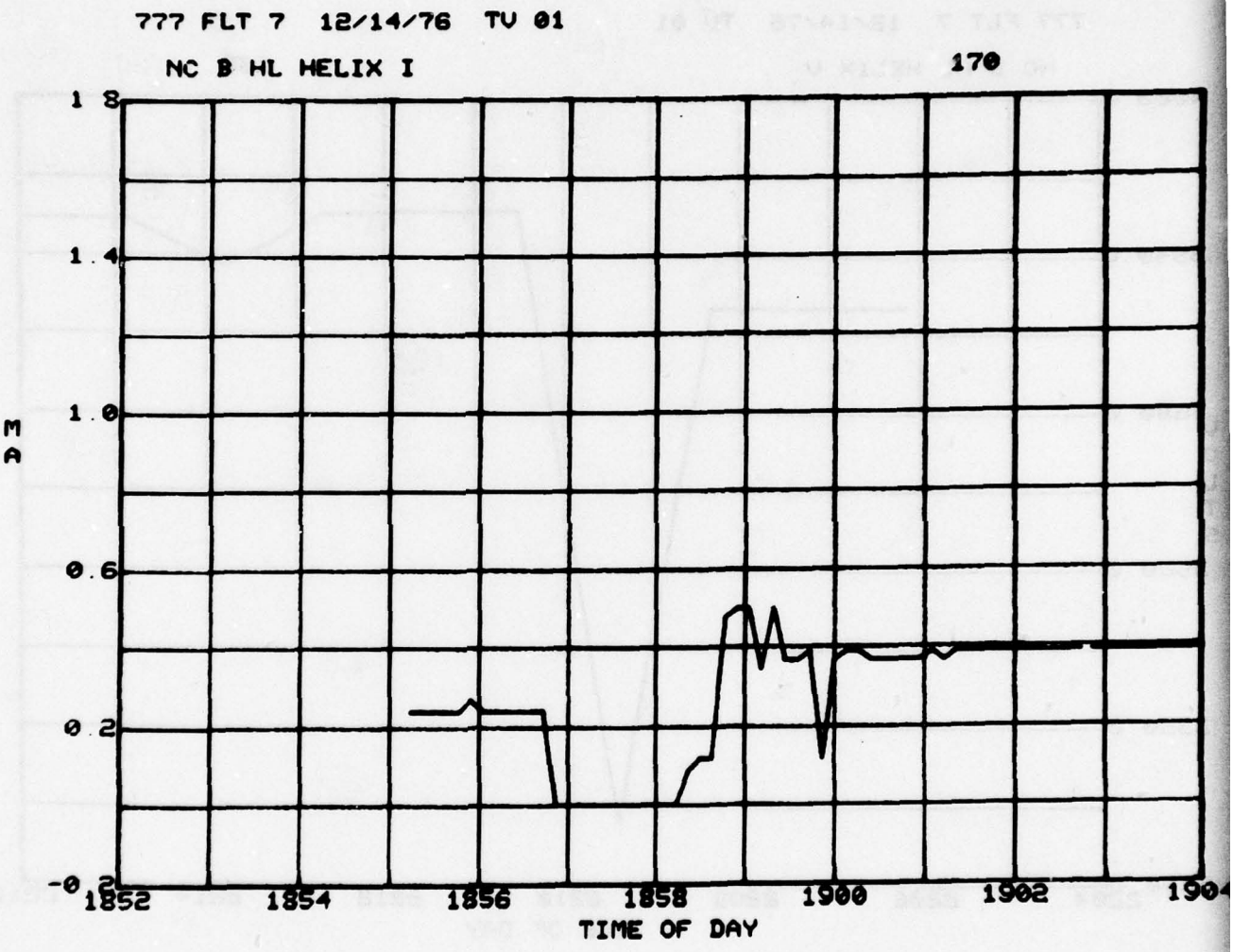
33.0
32.0
31.0
30.0
VOLTS
1852
1854
1856
1858
1900
1902
1904
TIME OF DAY


777 FLT 7 12/14/76 TV 01
NC B HL HELIX I
170
1.8
1.4
1.0
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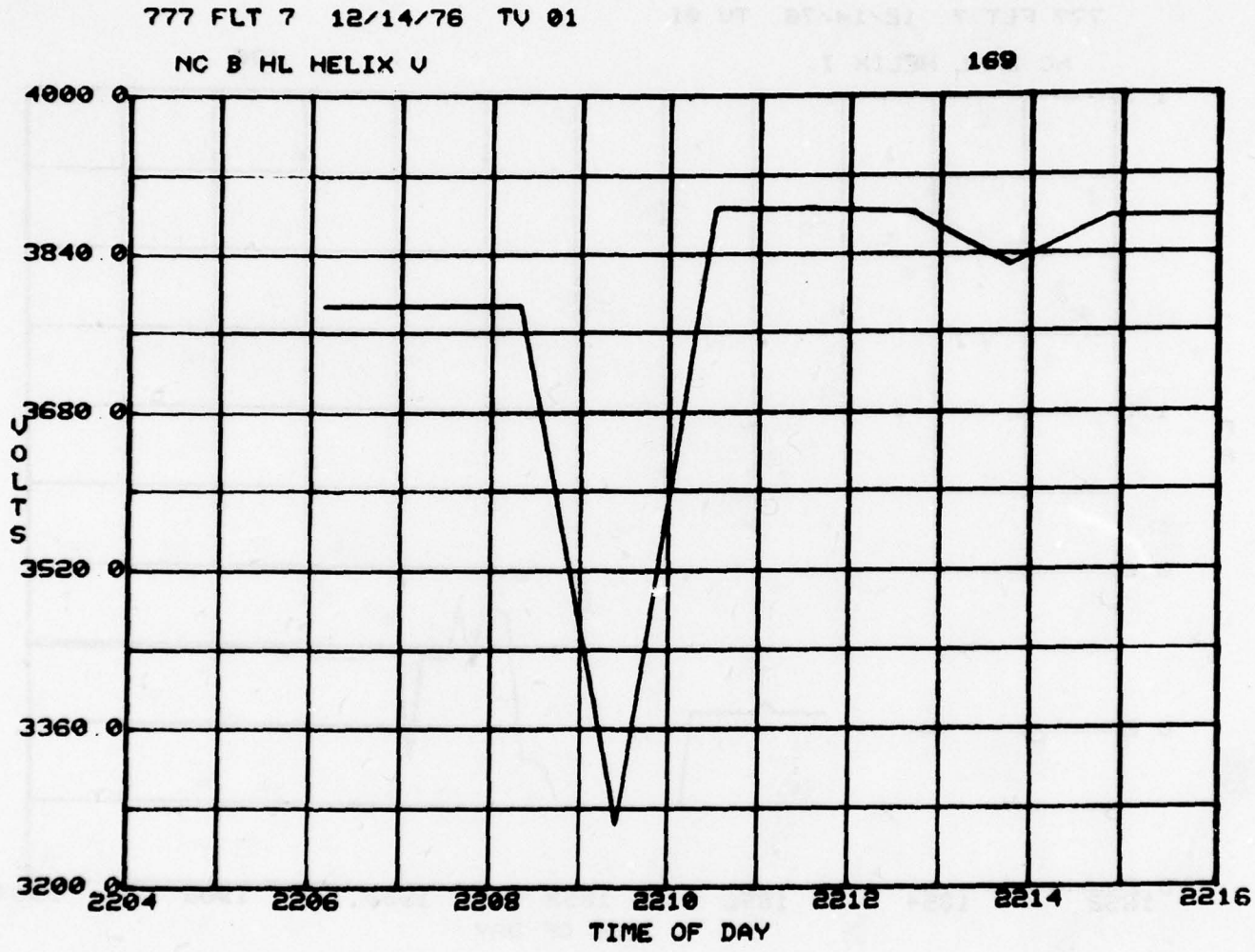
0.2
-0.2
MA
1852
1854
1856
1858
1900
1902
1904
TIME OF DAY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NC B HL HELIX V
169
4000.0
3840.0
3680.0
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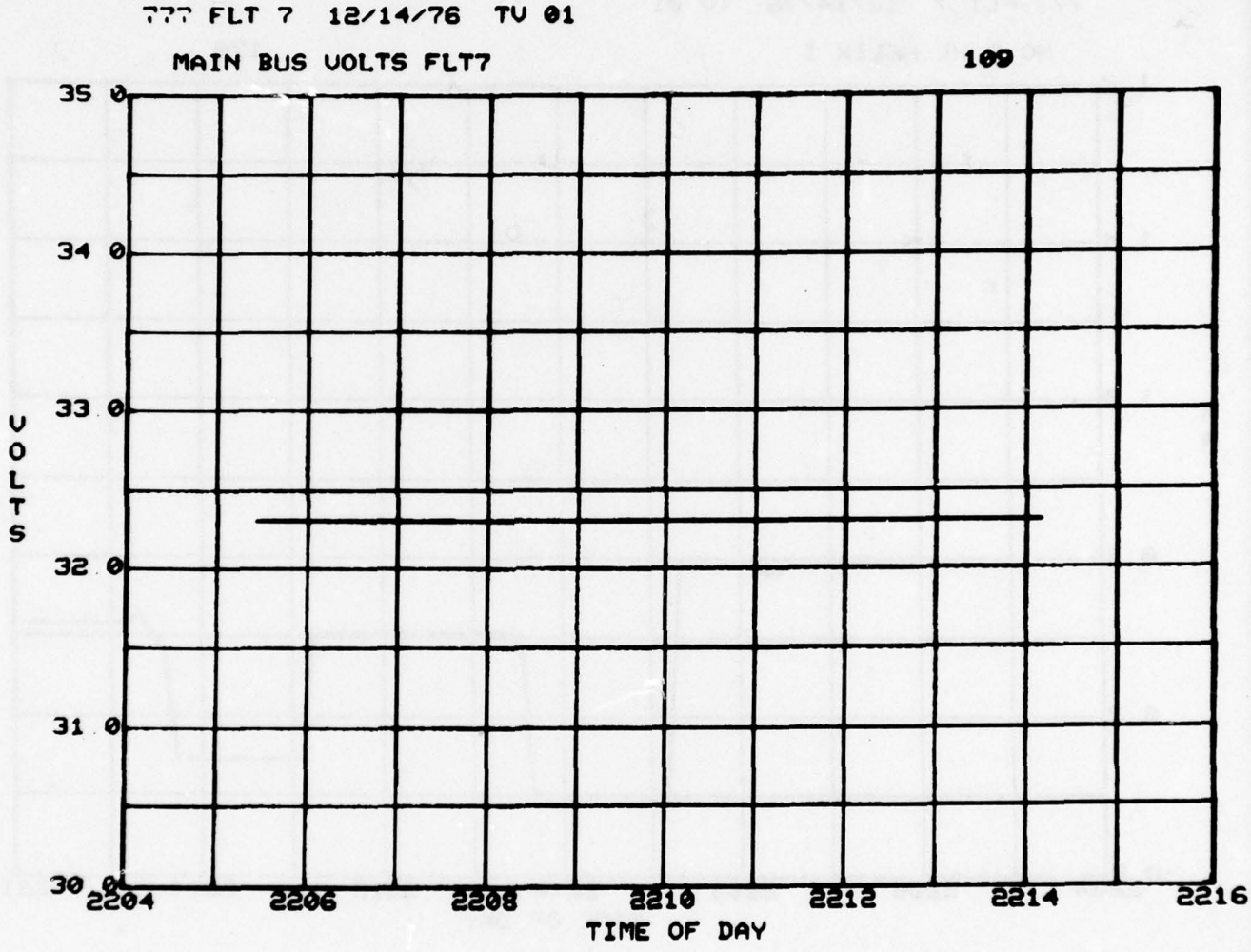
3360.0
3200.0
VOLTS
2204
2206
2208
2210
2212
2214
2216
TIME OF DAY


??? FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
109
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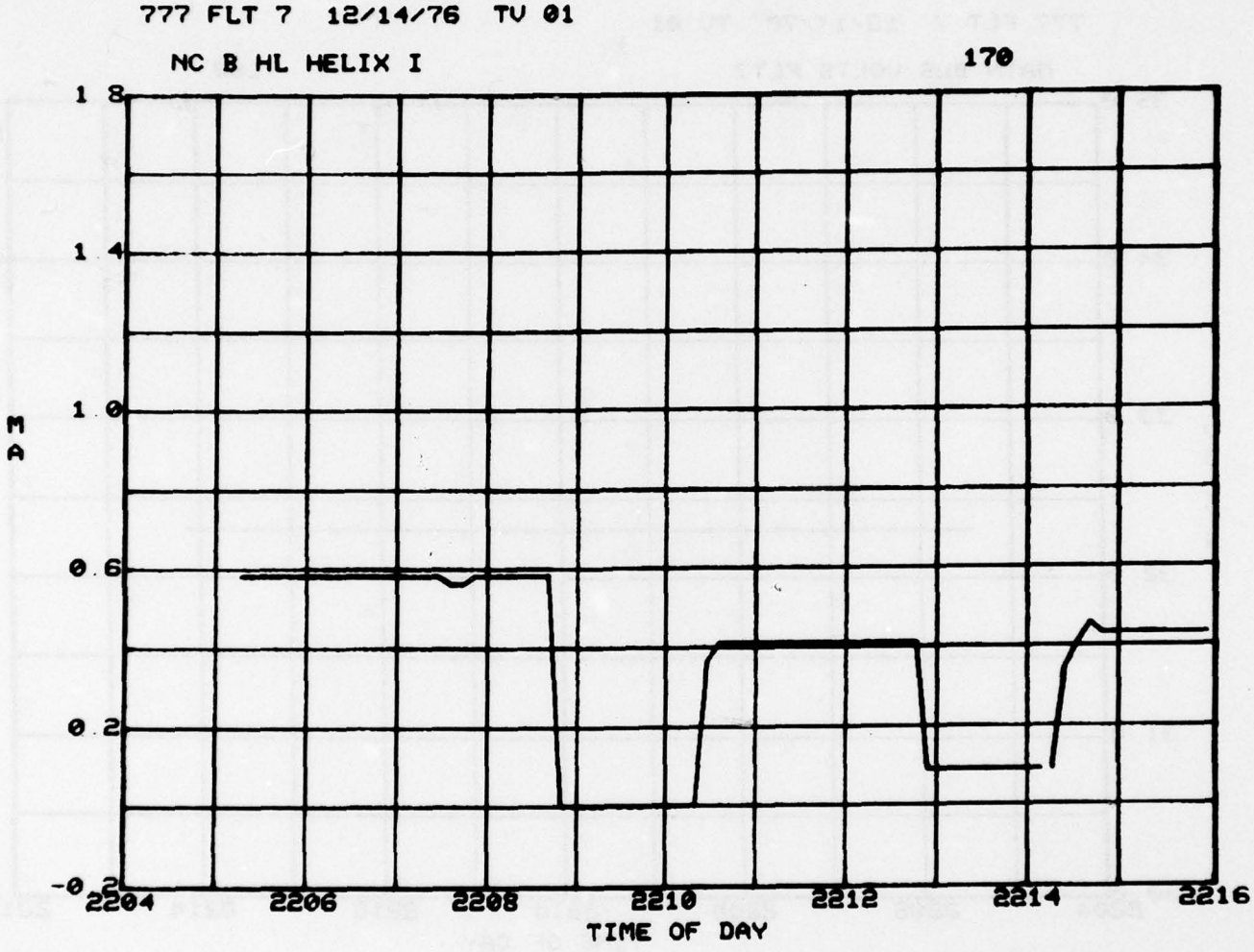
34 0
33 0
32 0
31 0
30 0
VOLTS
2204
2206
2208
2210
2212
2214
2216
TIME OF DAY


777 FLT 7 12/14/76 TV 01
NC B HL HELIX I
170
1.8
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1.0
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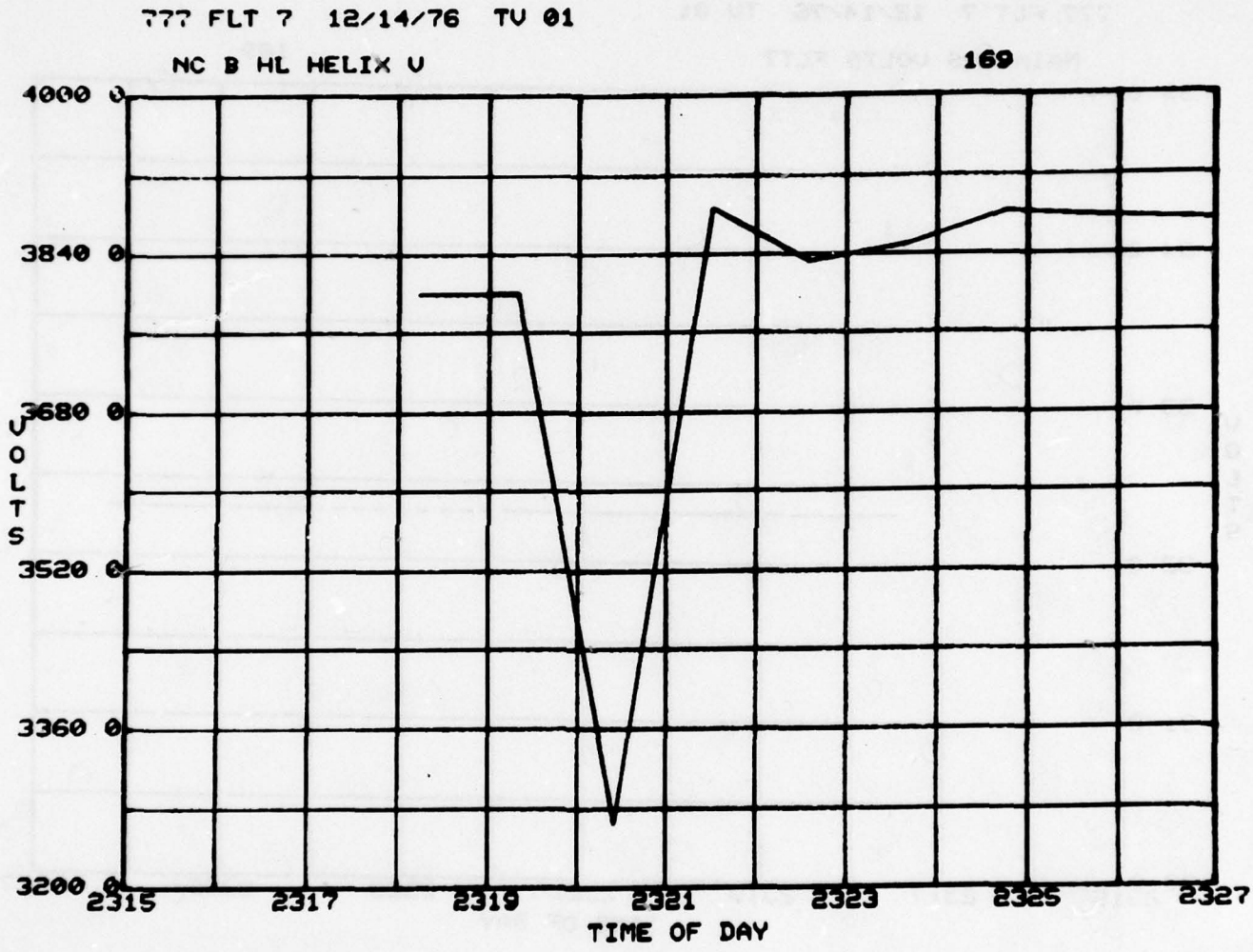
0.2
-0.2
MA
2204
2206
2208
2210
2212
2214
2216
TIME OF DAY


777 FLT 7 12/14/76 TV 01
NC B HL HELIX V
169
4000 0
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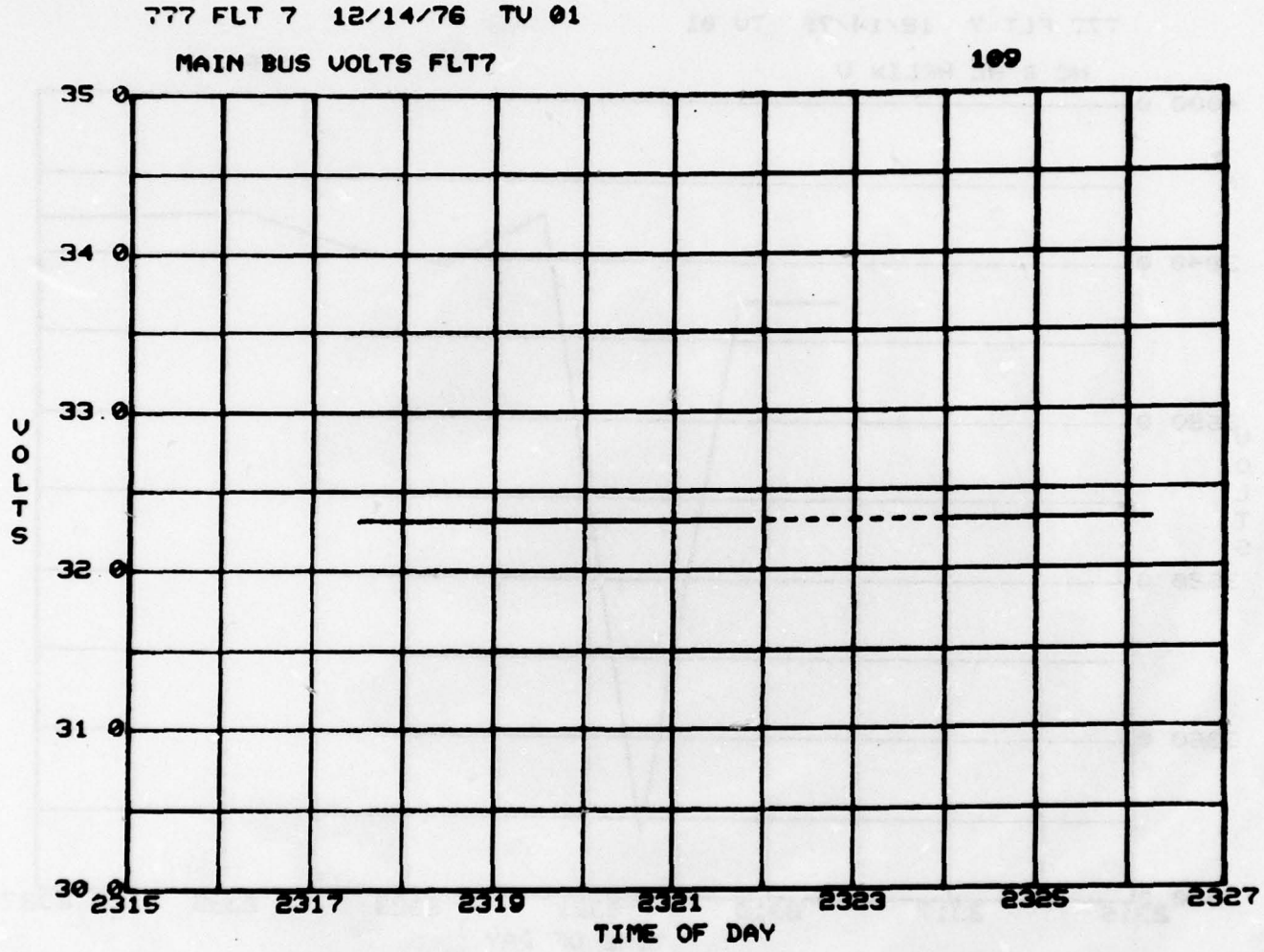
3680 0
3520 0
3360 0
3200 0
VOLTS
2315
2317
2319
2321
2323
2325
2327
TIME OF DAY


777 FLT 7 12/14/76 TV 01
MAIN BUS VOLTS FLT7
109
35.0
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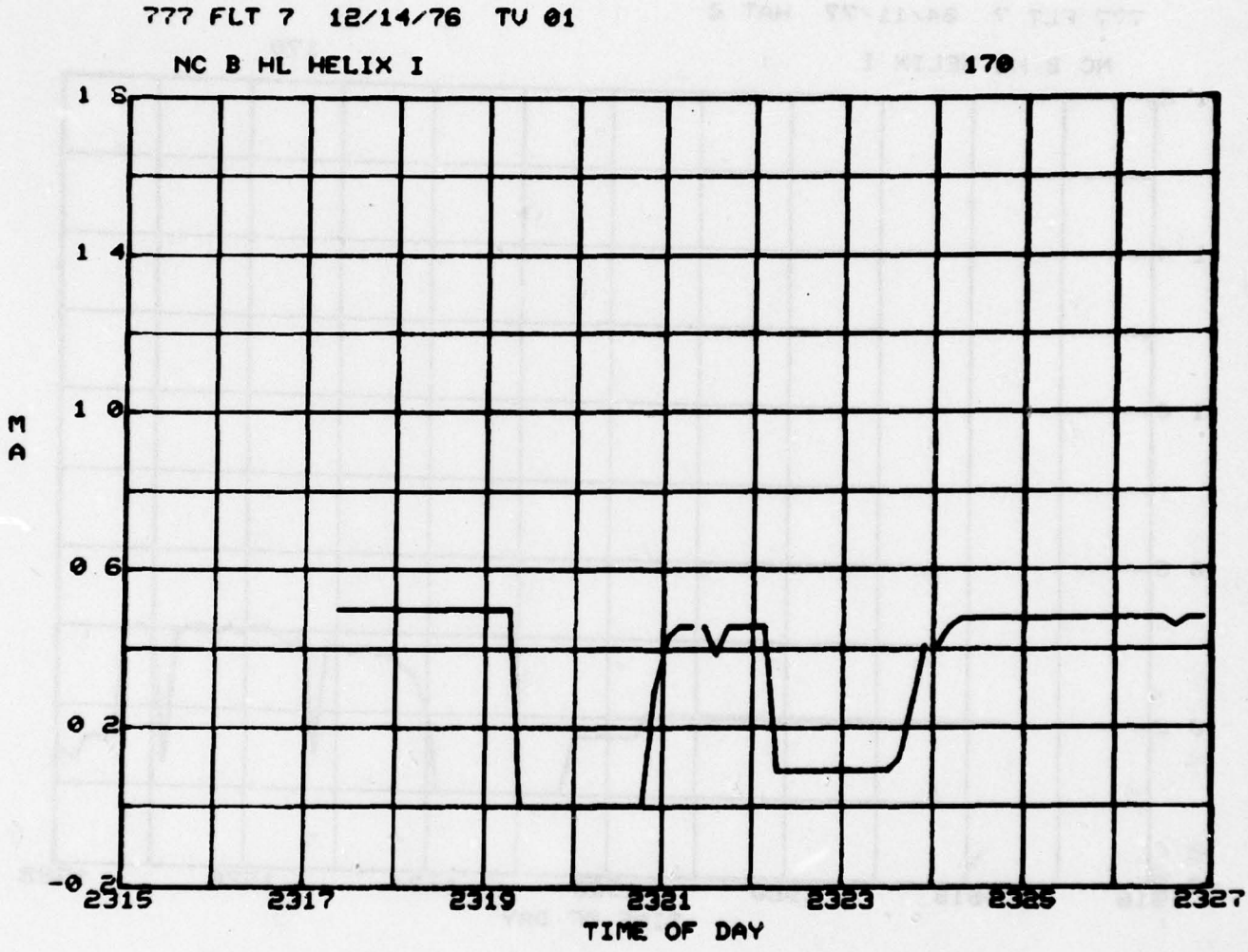
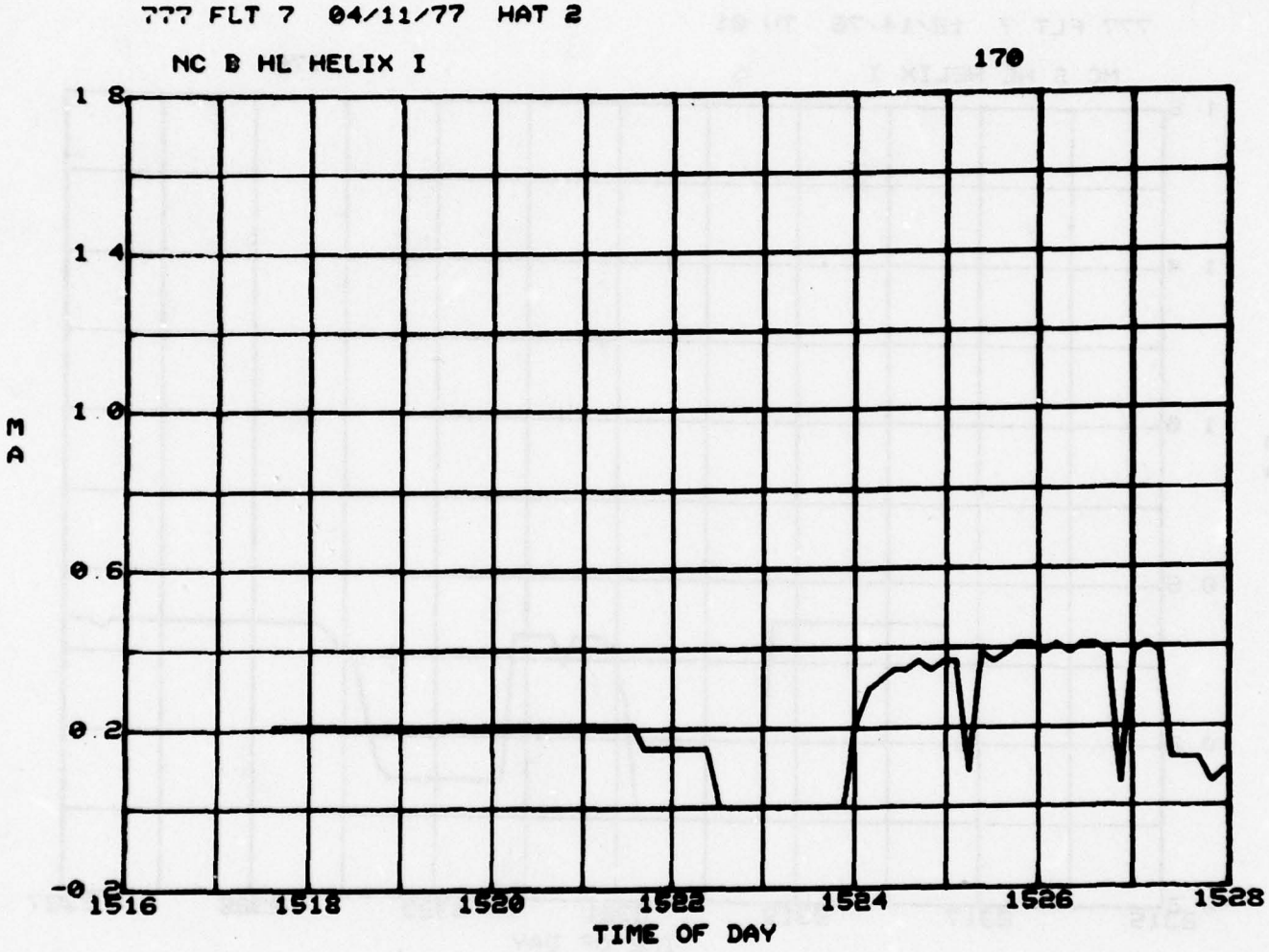
33.0
32.0
31.0
30.0
VOLTS
2315
2317
2319
2321
2323
2325
2327
TIME OF DAY


777 FLT 7 12/14/76 TU 01
NC B HL HELIX I
170
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
2315
2317
2319
2321
2323
2325
2327
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC B HL HELIX I
170
1.8
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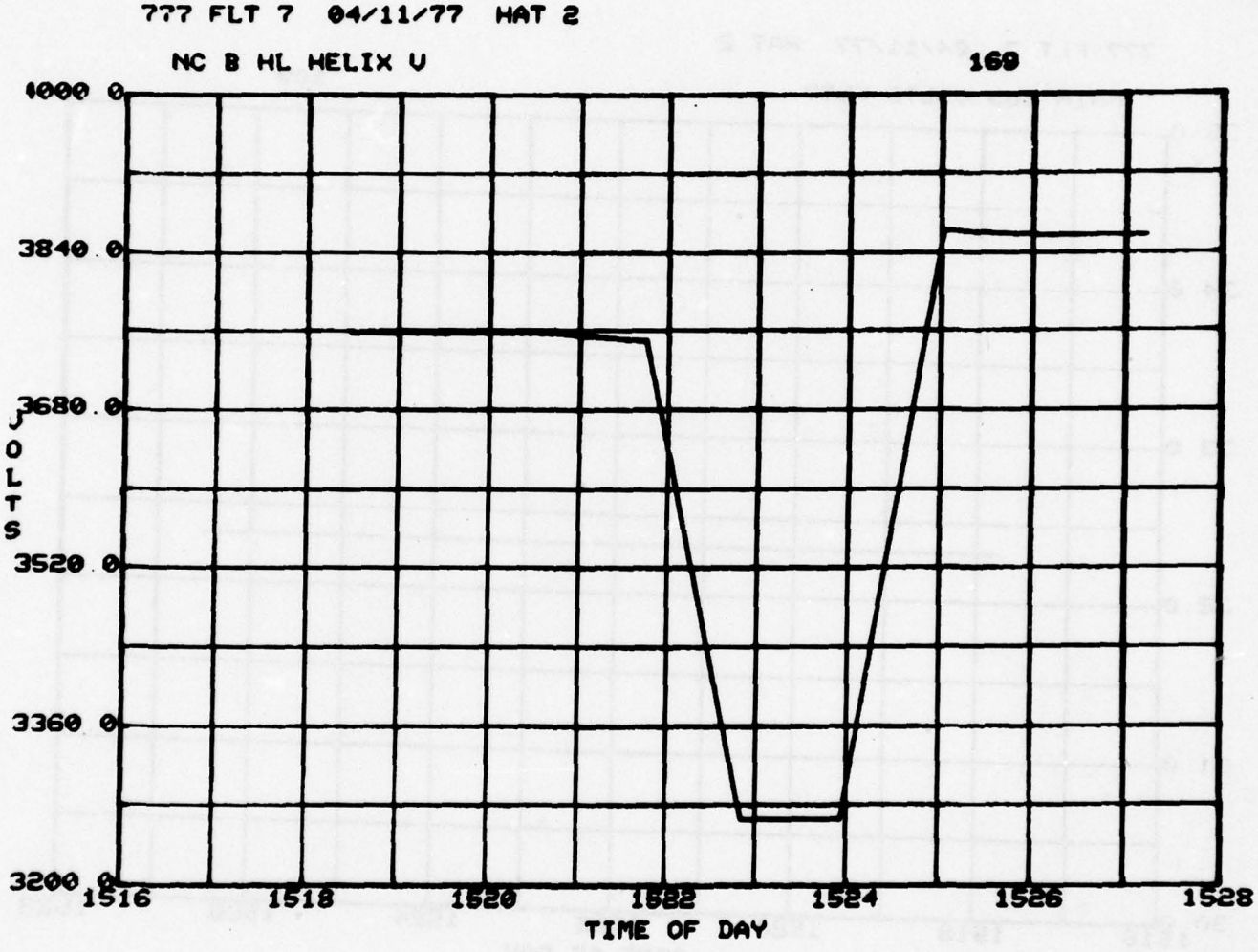
1.0
0.6
0.2
-0.2
MA
1516
1518
1520
1522
1524
1526
1528
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC B HL HELIX U
160
4000 0
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3680 0
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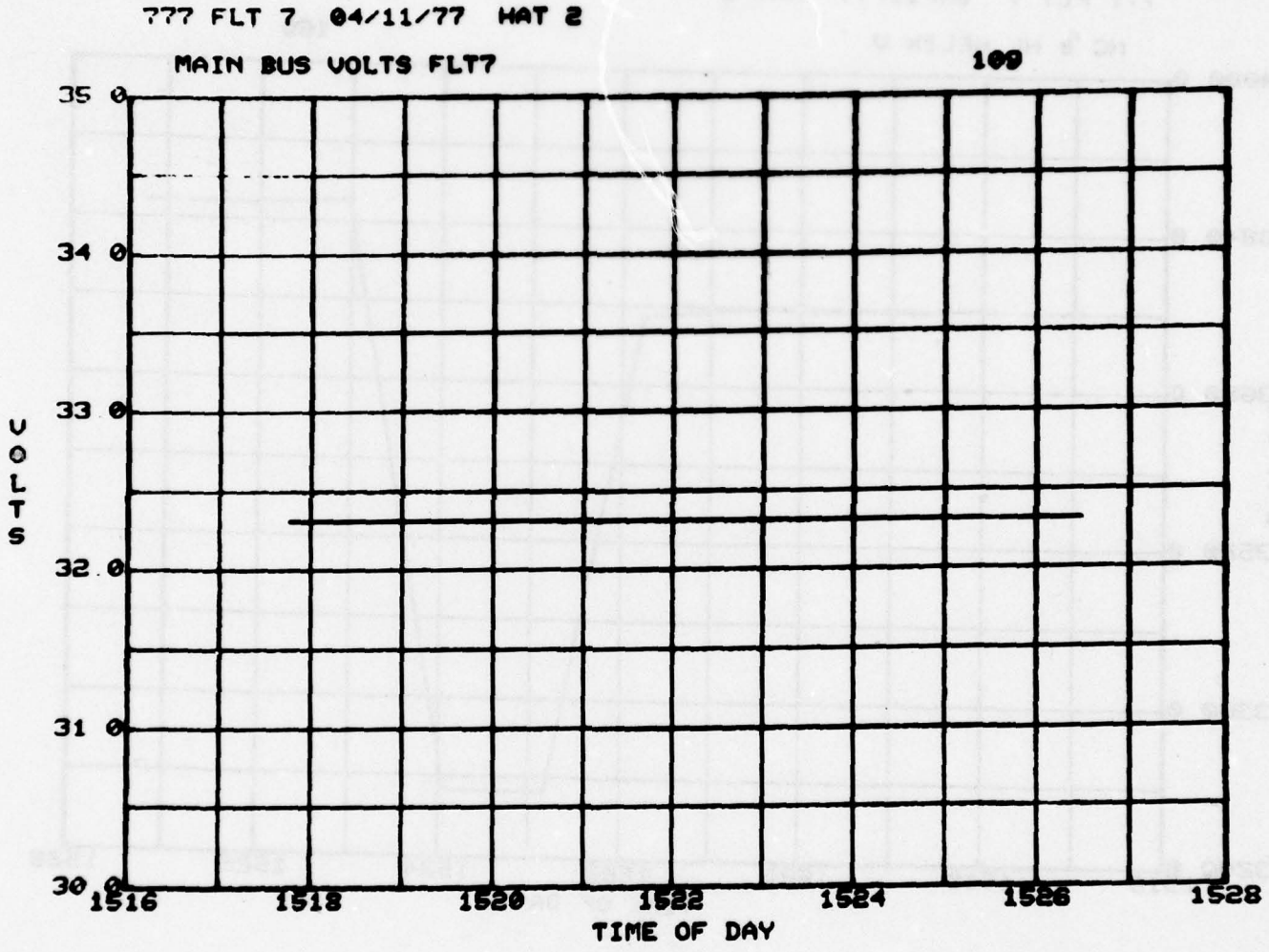
3360 0
3200 0
VOLTS
1516
1518
1520
1522
1524
1526
1528
TIME OF DAY


777 FLT 7 04/11/77 MAT 2
MAIN BUS VOLTS FLT7
109
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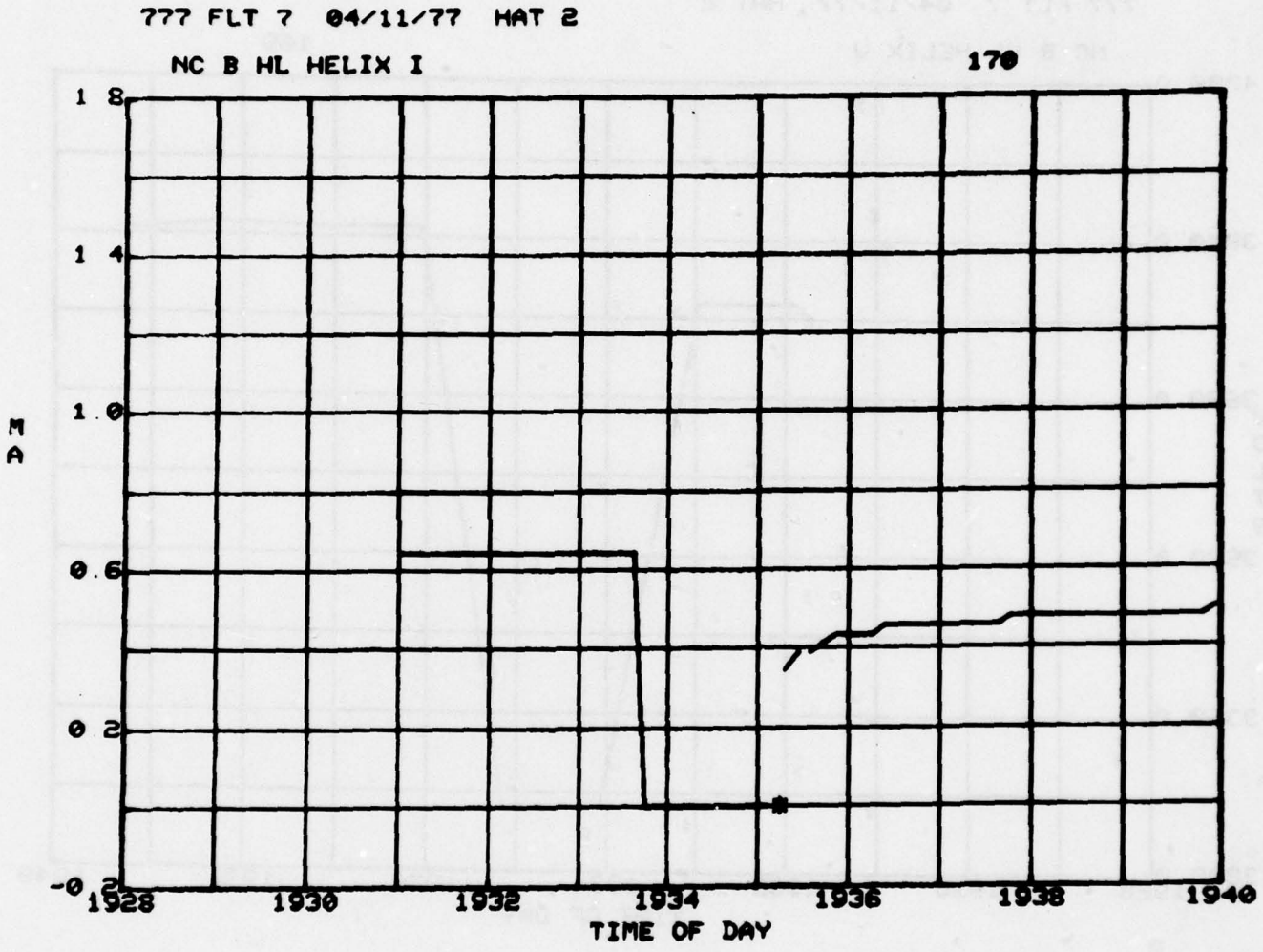
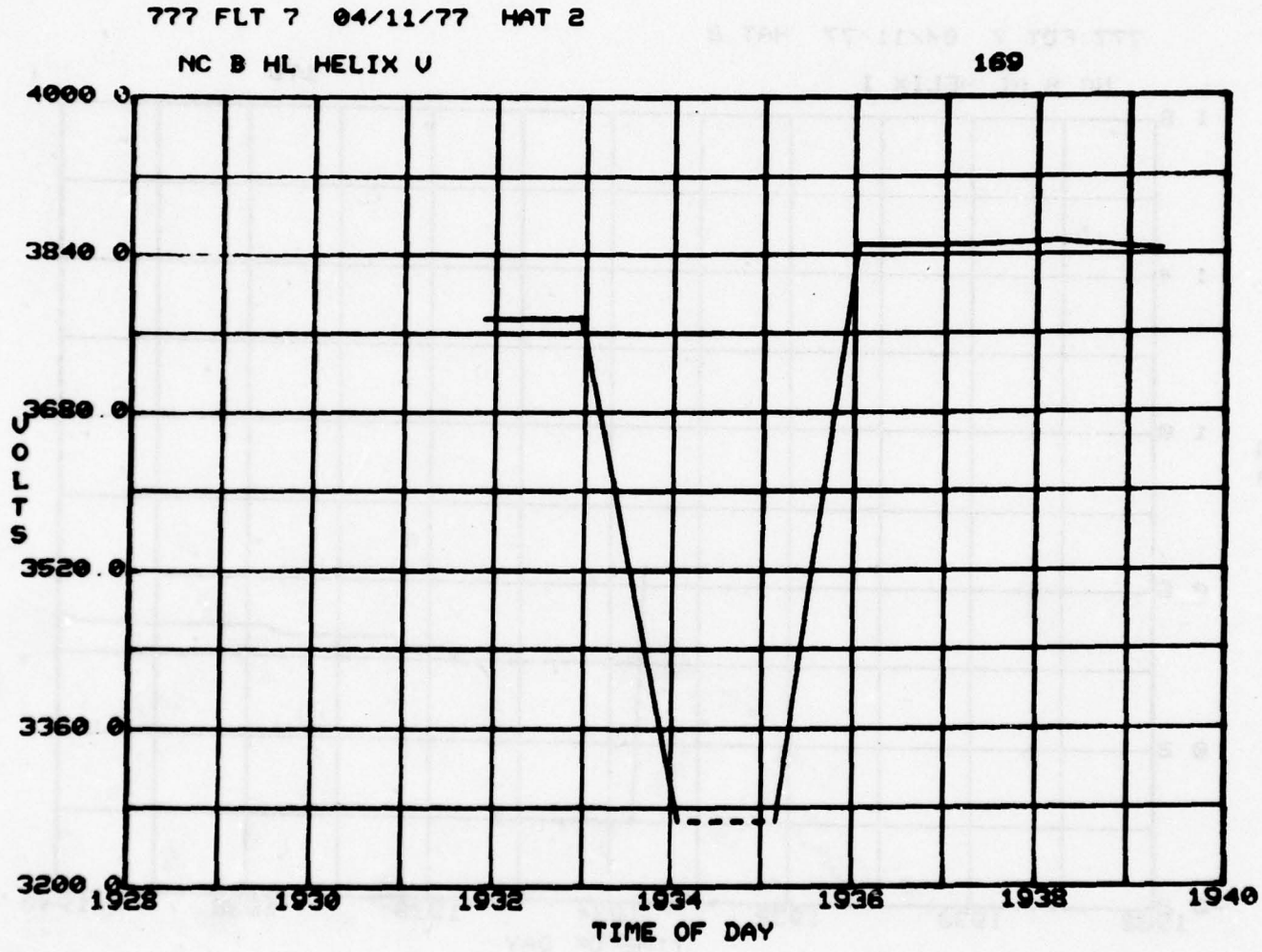
34 0
33 0
32 0
31 0
30 0
VOLTS
1516
1518
1520
1522
1524
1526
1528
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC B HL HELIX I
170
1 8
1 4
1 0
0 6
0 2
-0 2
MA
1928
1930
1932
1934
1936
1938
1940
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
NC B HL HELIX V
169
4000.0
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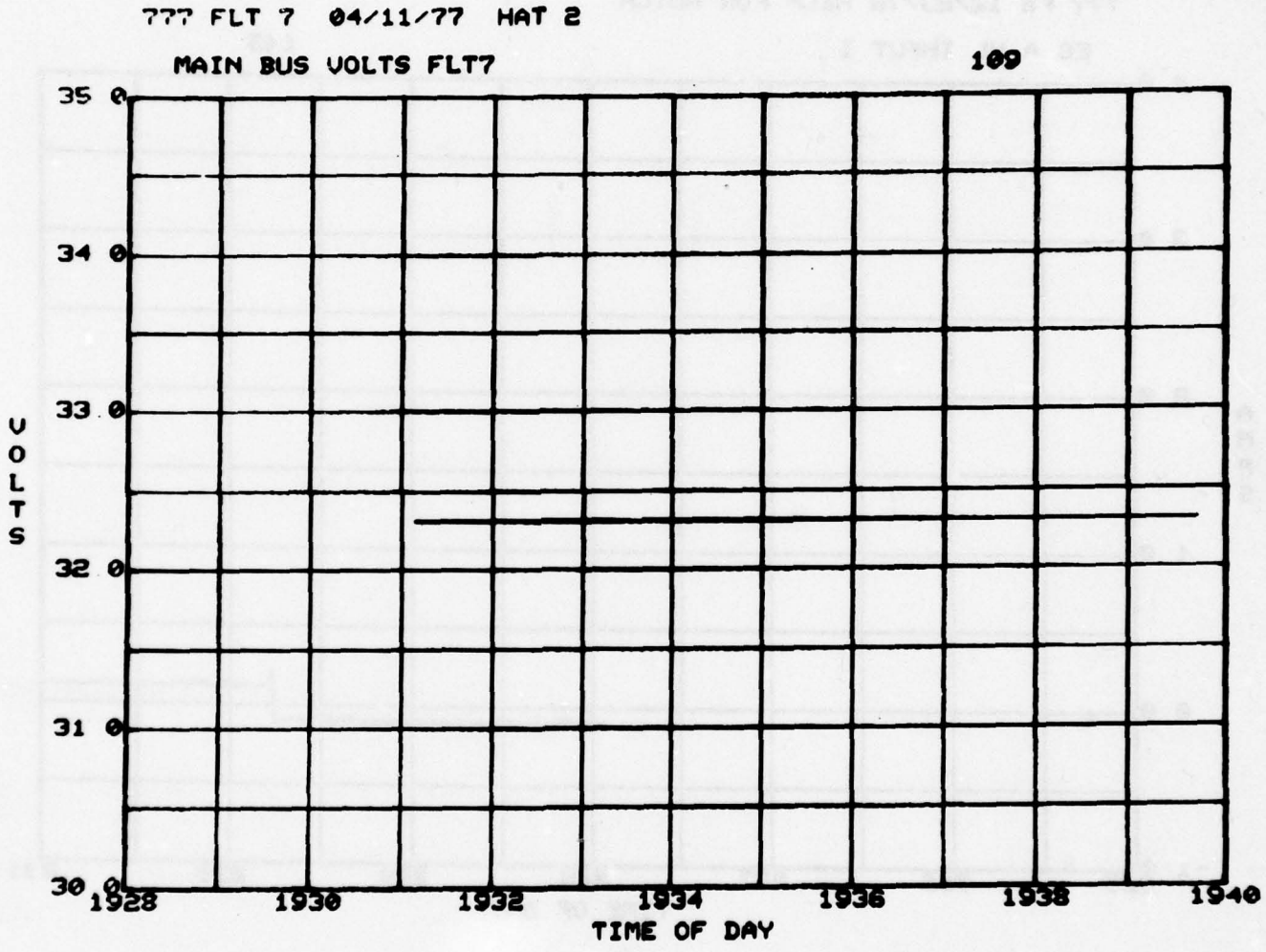
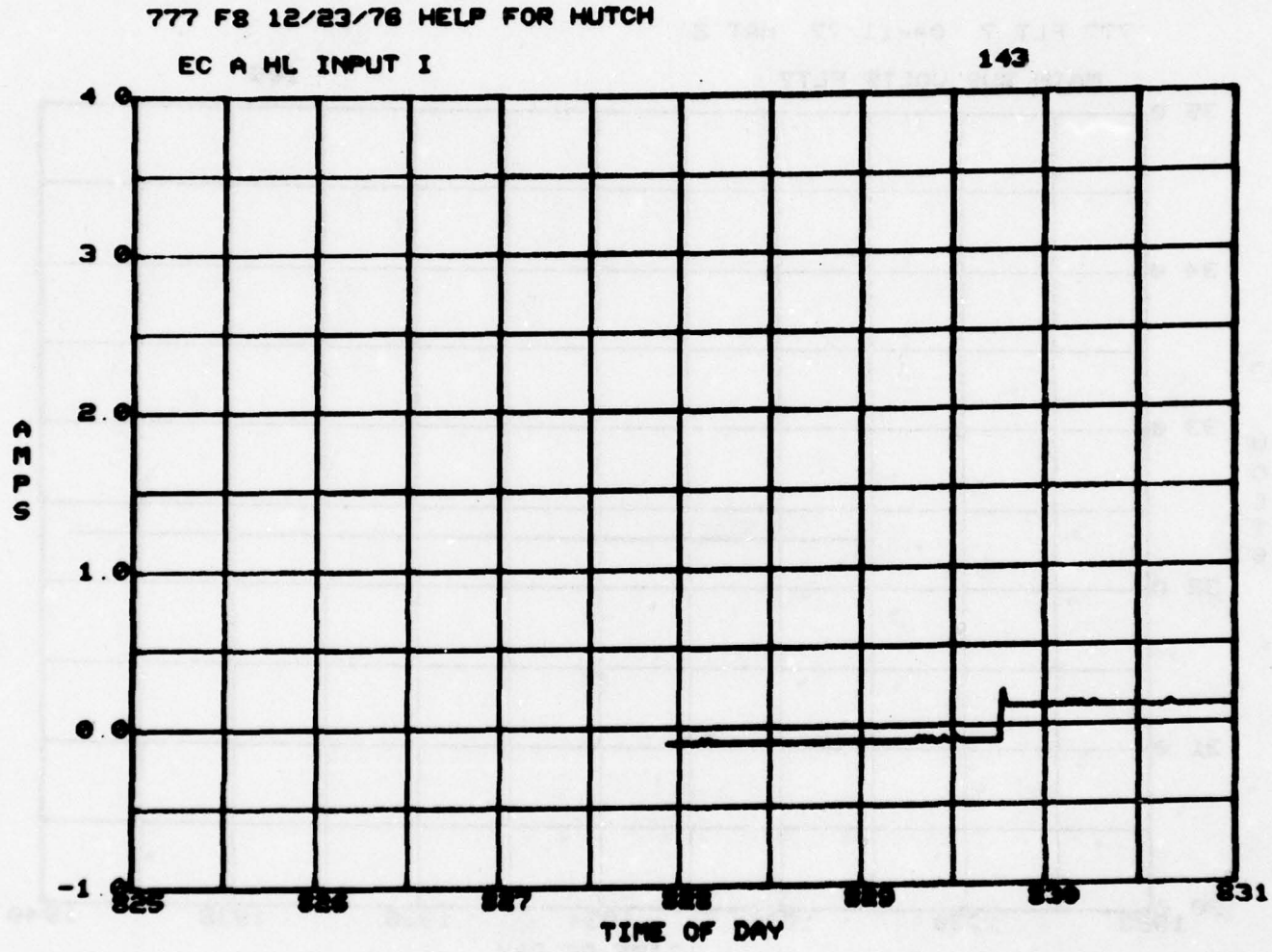
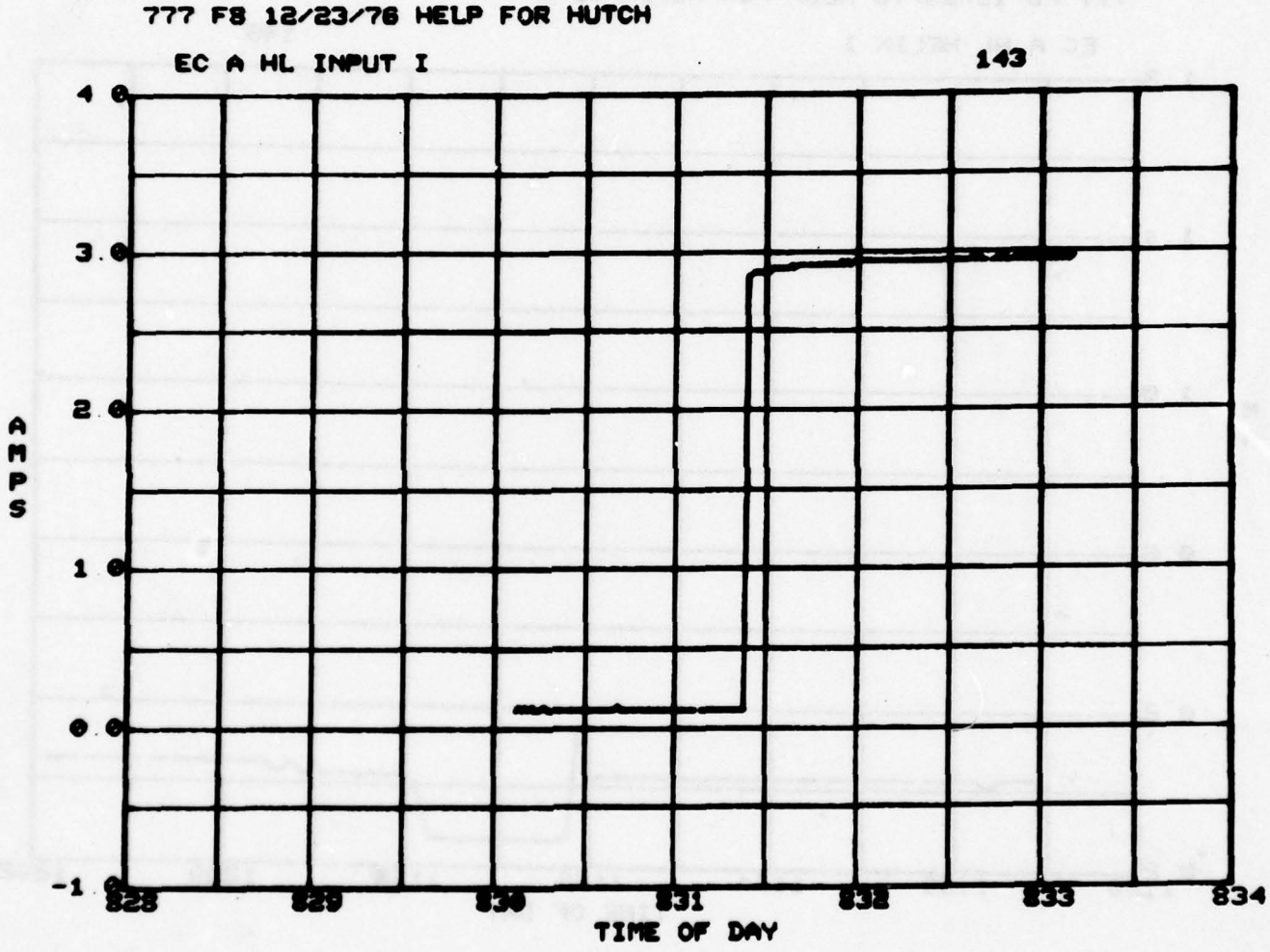
3680.0
3520.0
3360.0
3200.0
VOLTS
1928
1930
1932
1934
1936
1938
1940
TIME OF DAY


777 FLT 7 04/11/77 HAT 2
MAIN BUS VOLTS FLT7
109
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
1928
1930
1932
1934
1936
1938
1940
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC A HL INPUT I
143
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
825
826
827
828
829
830
831
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC A HL INPUT I
143
4.0
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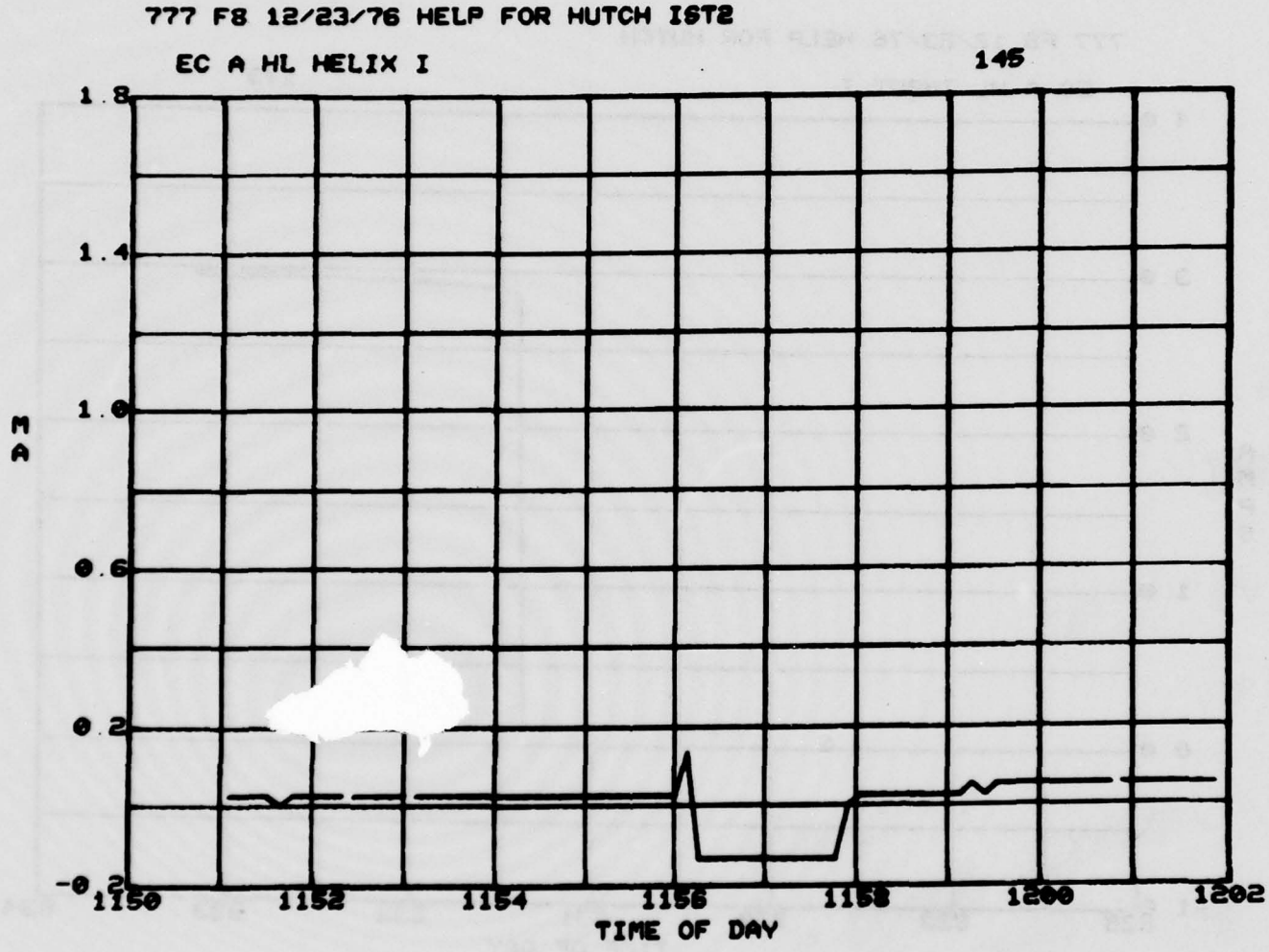
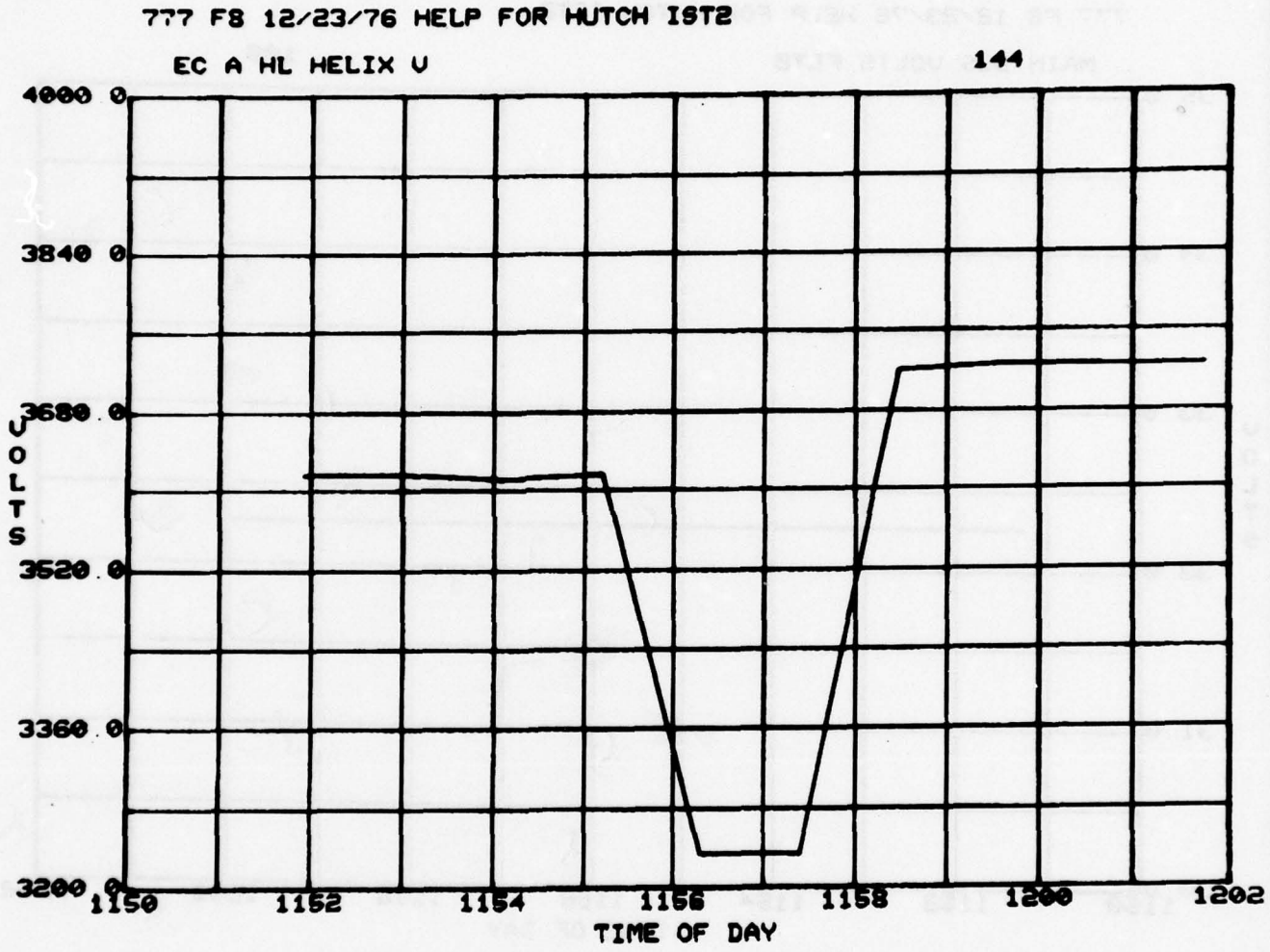
2.0
1.0
0.0
-1.0
AMPS
828
829
830
831
832
833
834
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH IST2
EC A HL HELIX I
145
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1150
1152
1154
1156
1158
1200
1202
TIME OF DAY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EC A HL HELIX V
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3840.0
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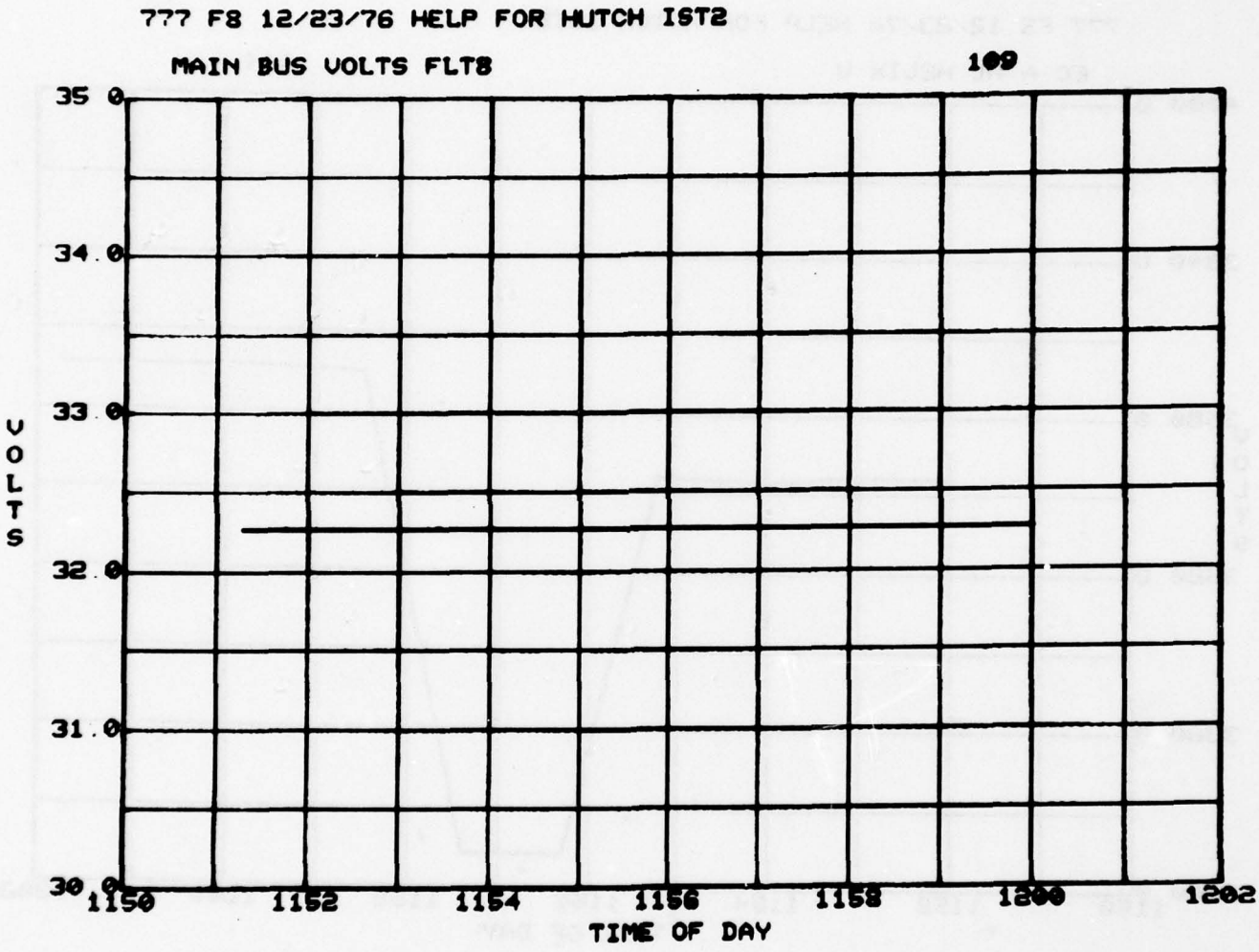
VOLTS
1150
1152
1154
1156
1158
1200
1202
TIME OF DAY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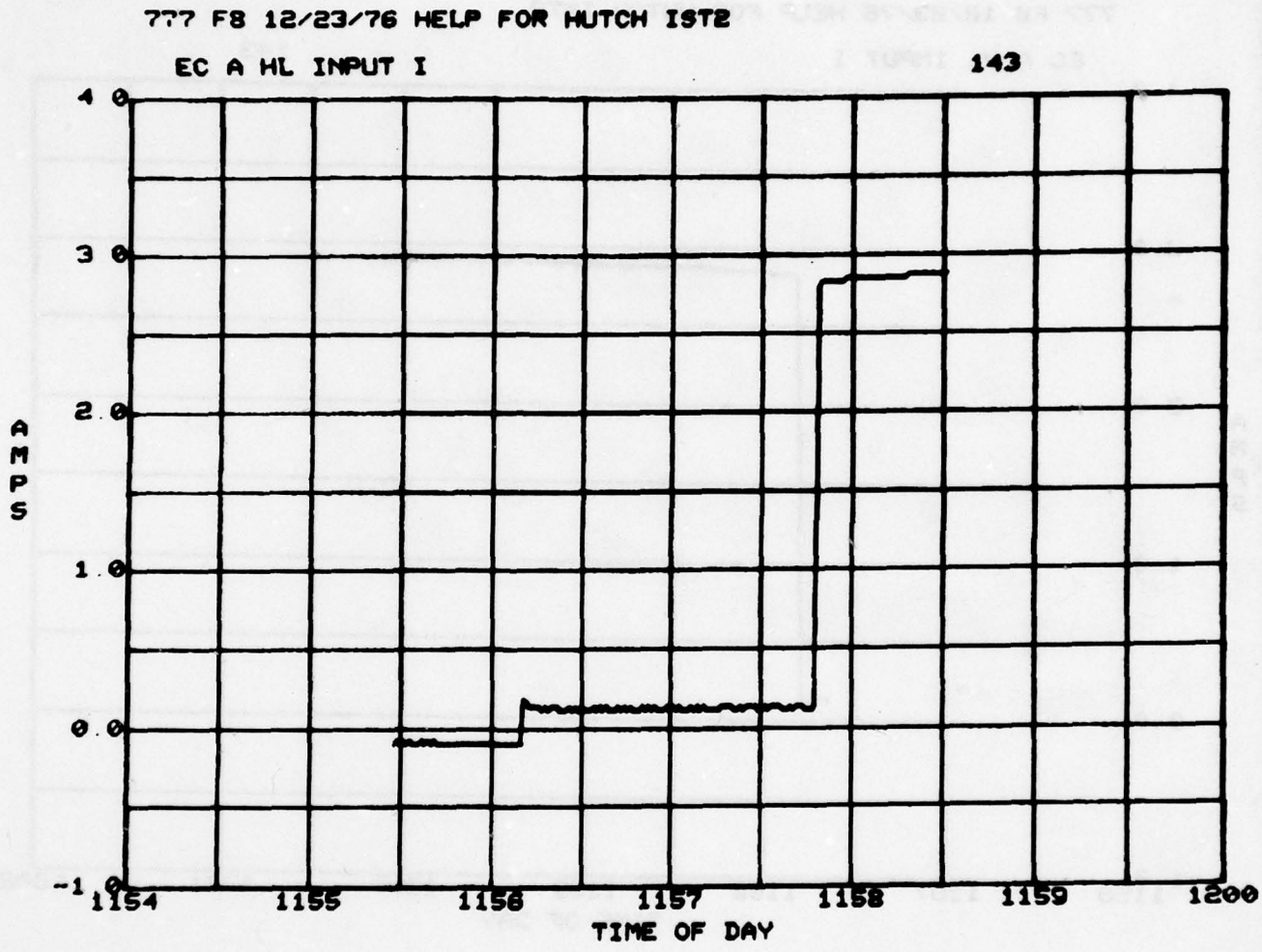
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1150
1152
1154
1156
1158
1200
1202
TIME OF DAY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-1.0
AMPS
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1156
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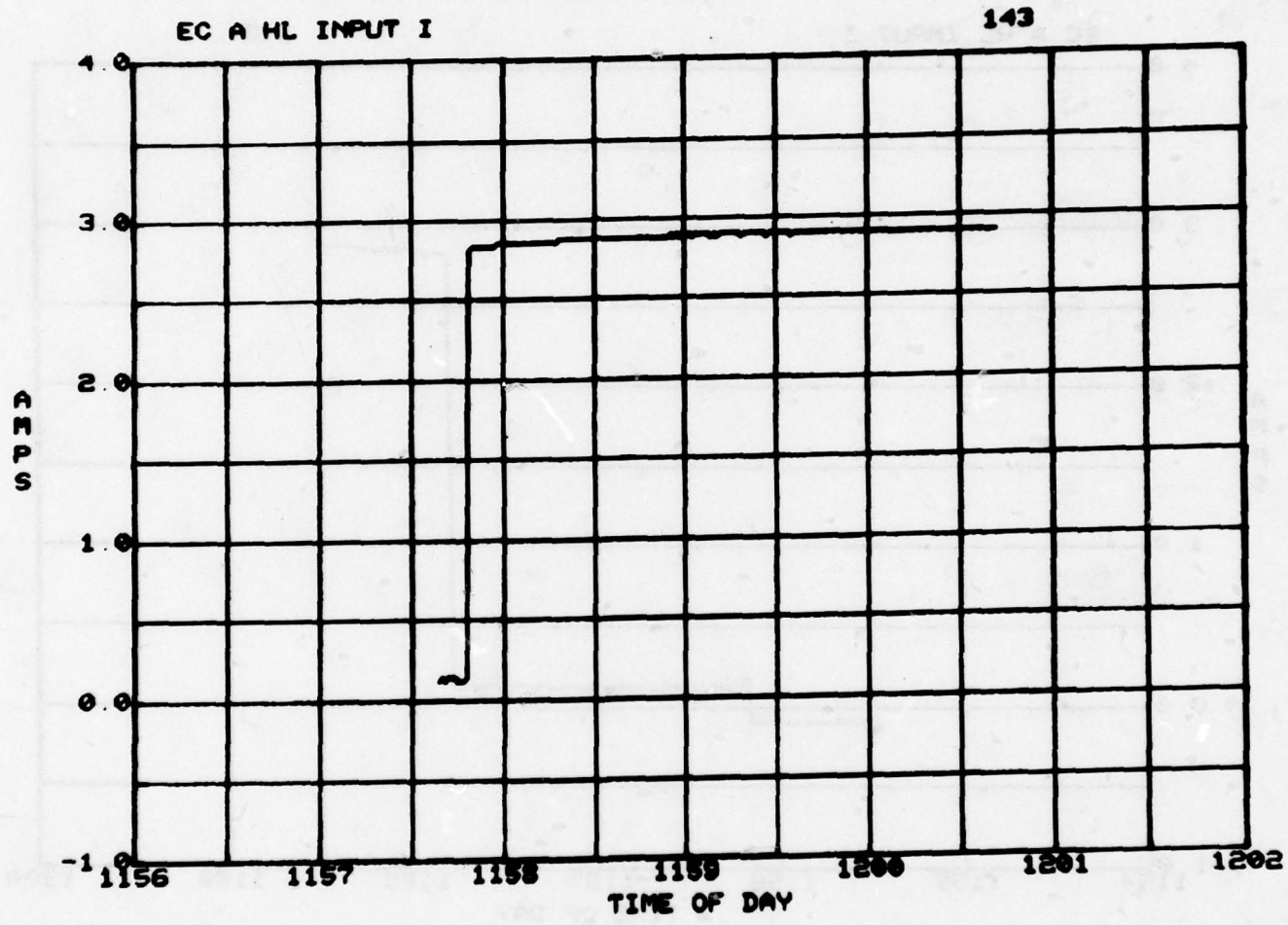
1158
1159
1200
TIME OF DAY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EC A HL INPUT I
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4.0
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-1.0
AMPS
1156
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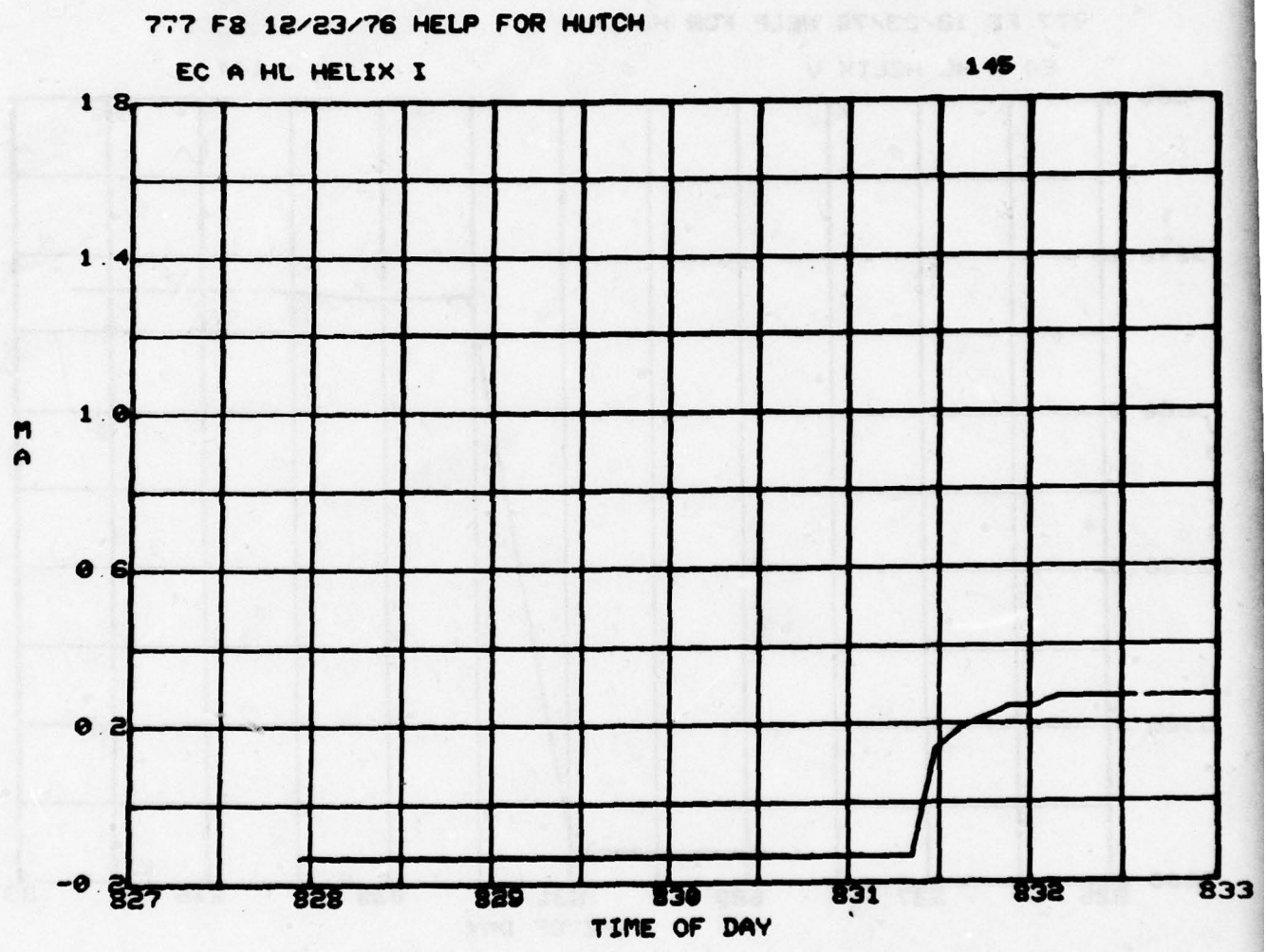
1158
1159
1200
1201
1202
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC A HL HELIX I
145
1.8
1.4
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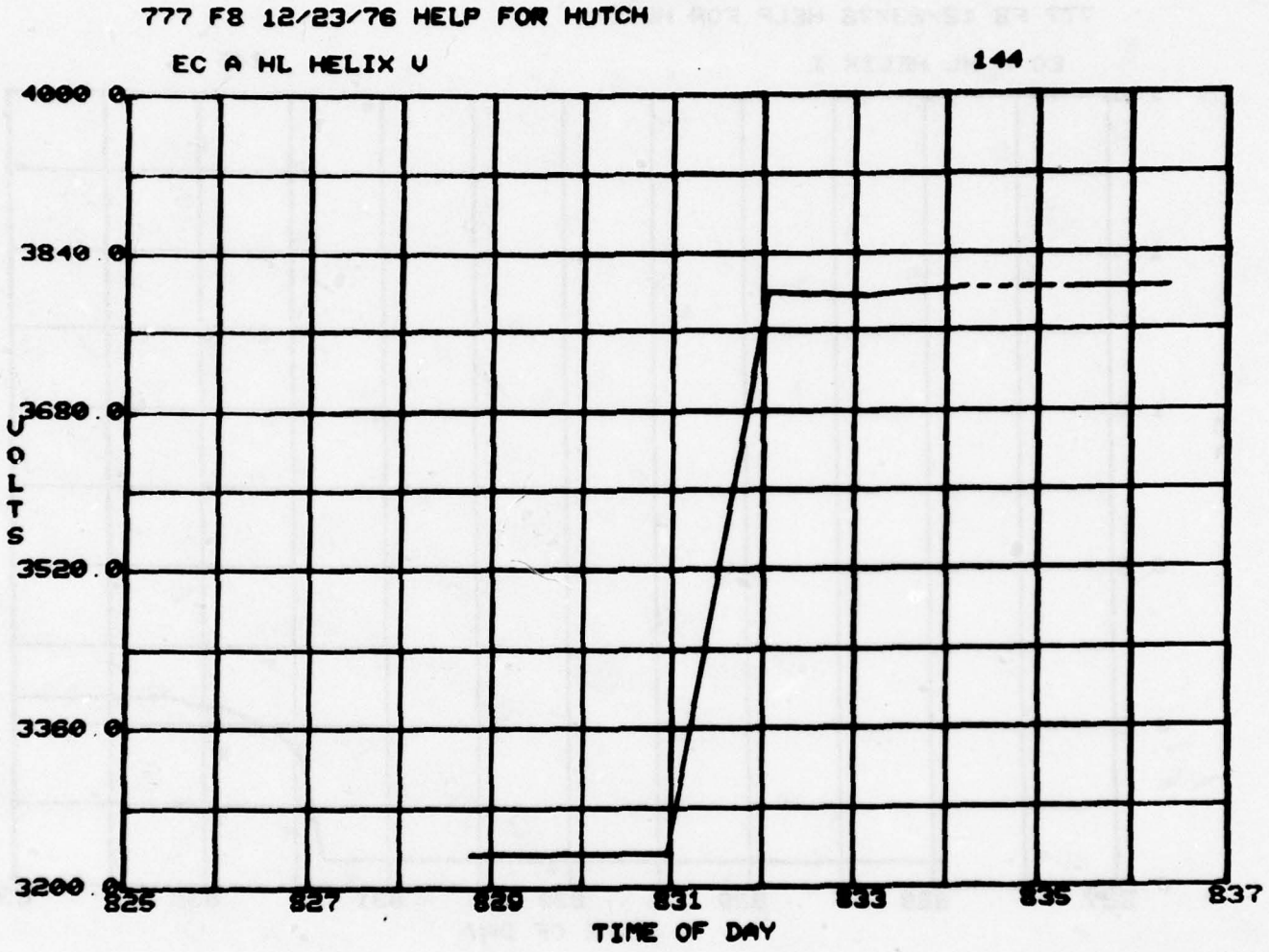
0.2
-0.2
MA
827
828
829
830
831
832
833
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC A HL HELIX V
144
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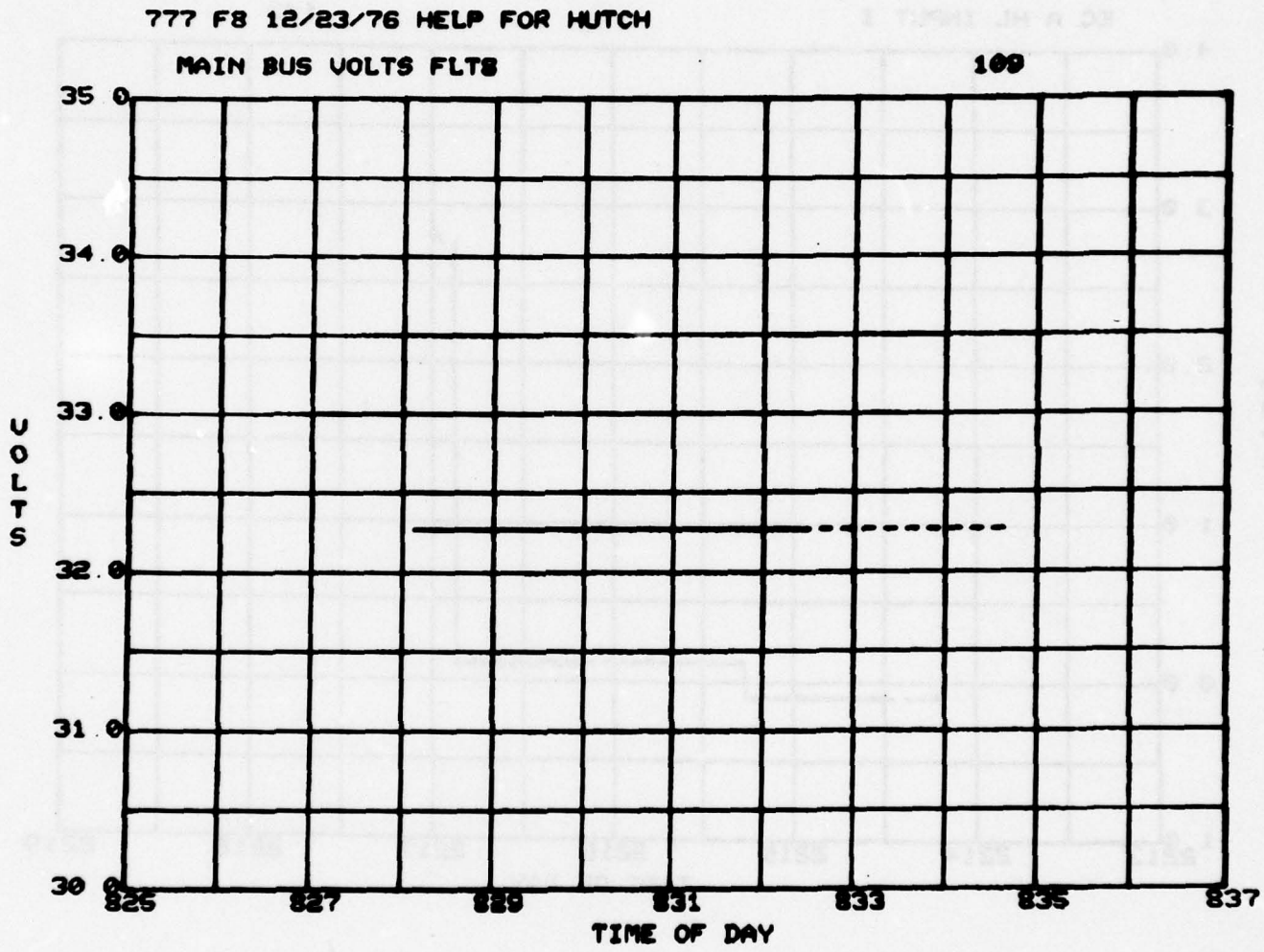
3200.0
VOLTS
825
827
829
831
833
835
837
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
100
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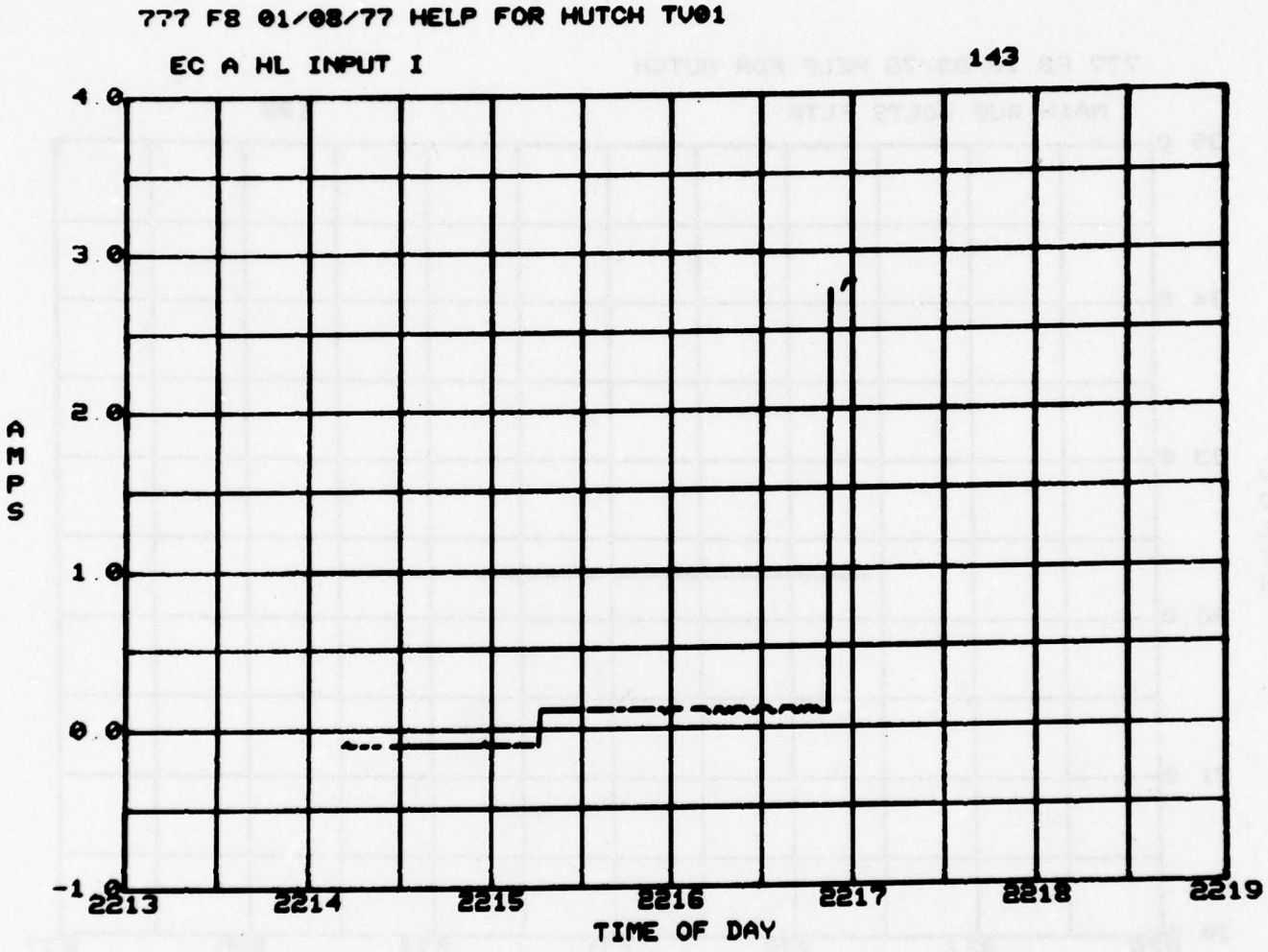
31.0
30.0
VOLTS
825
827
829
831
833
835
837
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC A HL INPUT I
143
4.0
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-1.0
AMPS
2213
2214
2215
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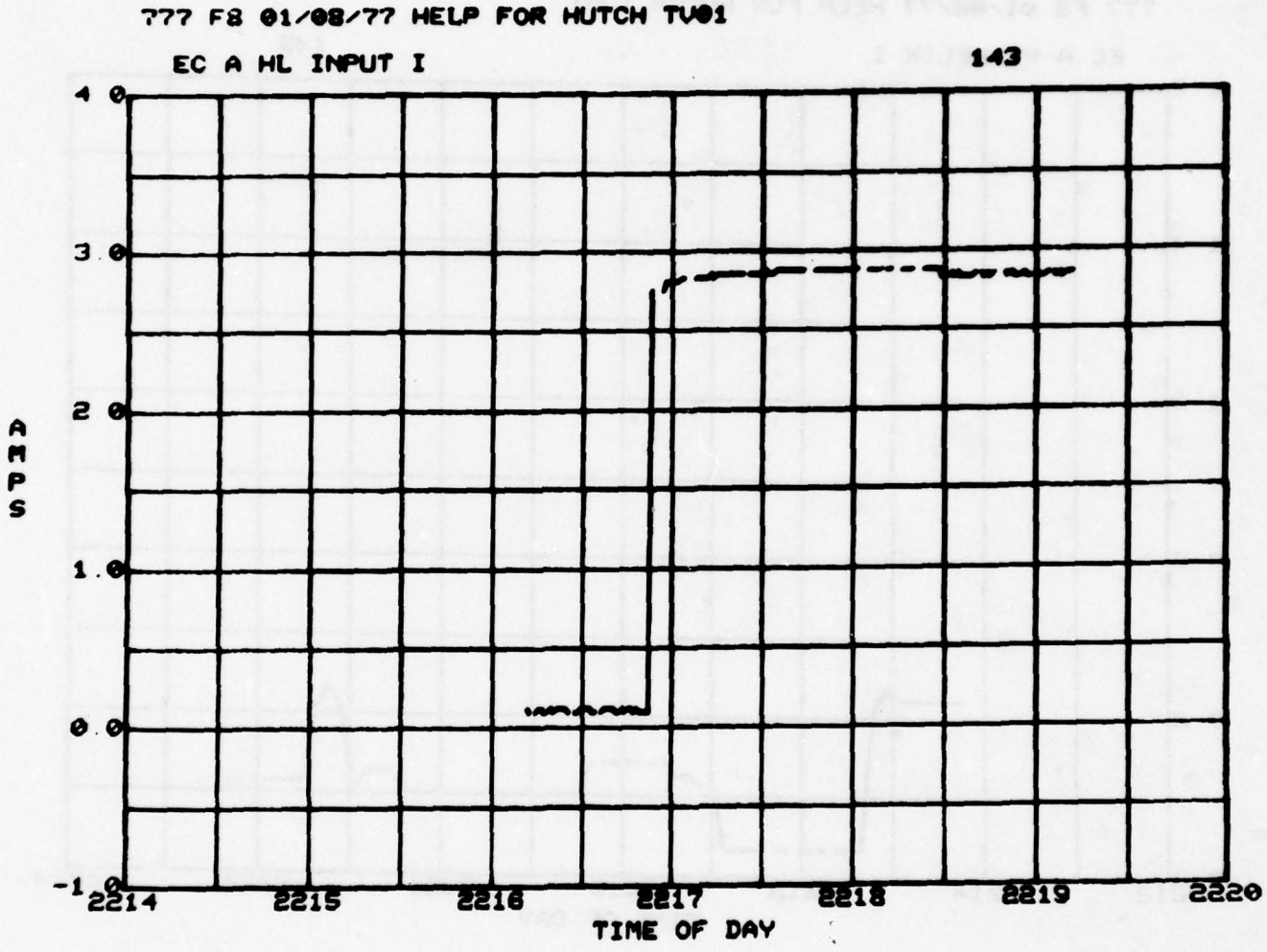
2218
2219
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC A HL INPUT I
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-1.0
AMPS
2214
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2216
2217
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2219
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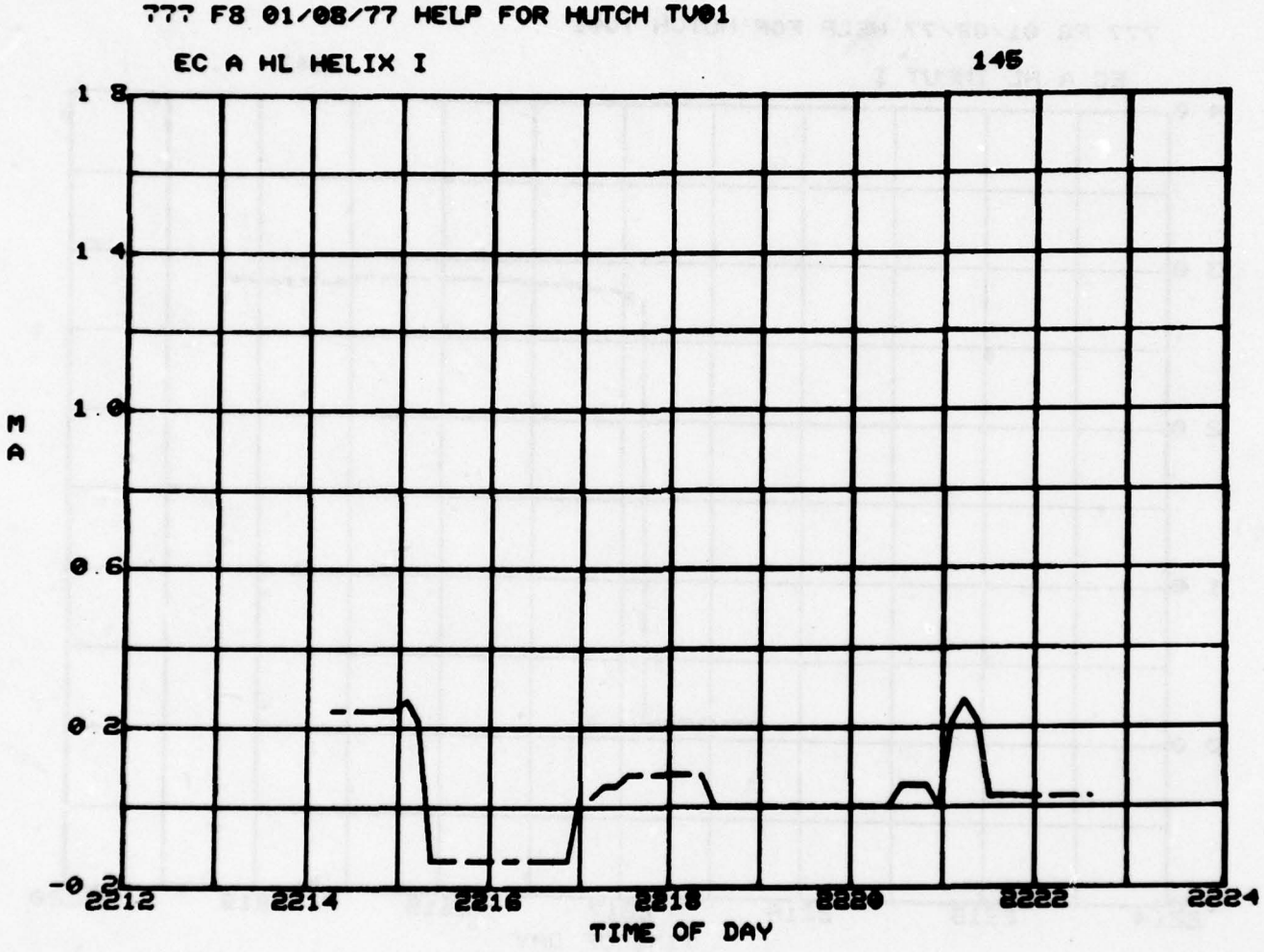
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC A HL HELIX I
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0 6
0 2
-0 2
MA
2212
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2216
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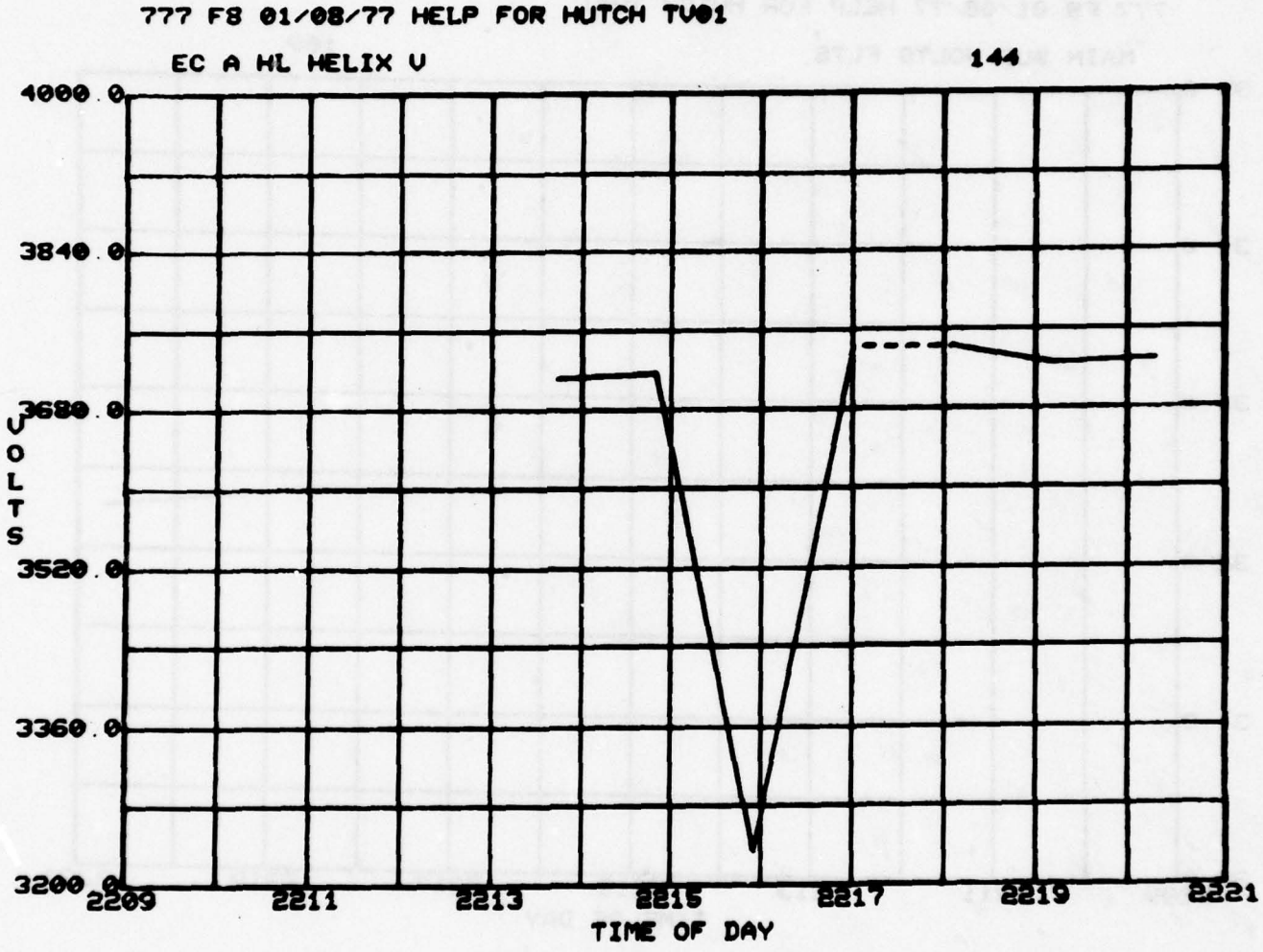
2222
2224
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC A HL HELIX V
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3200.0
VOLTS
2209
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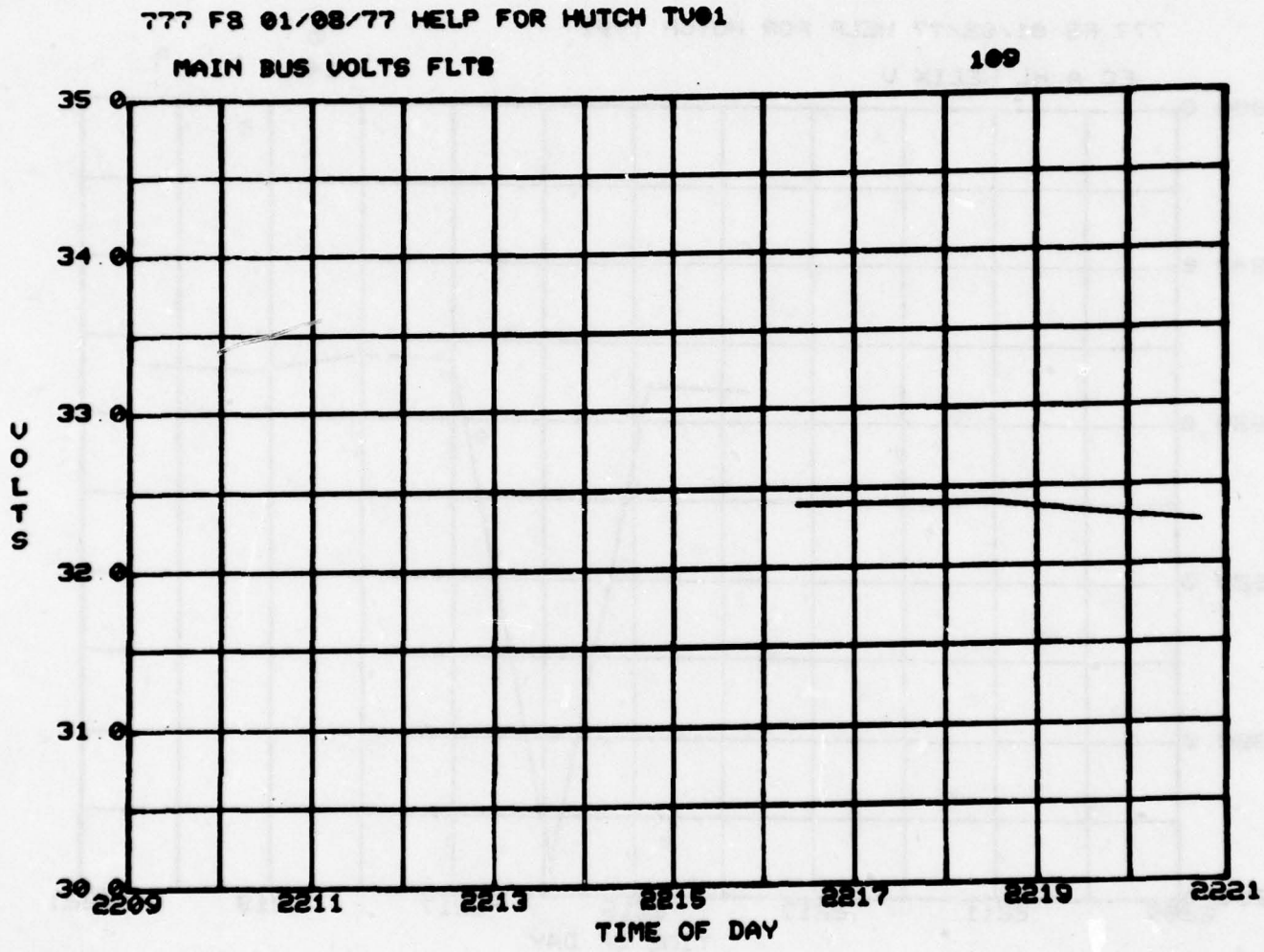
2221
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
MAIN BUS VOLTS FLT8
109
35.0
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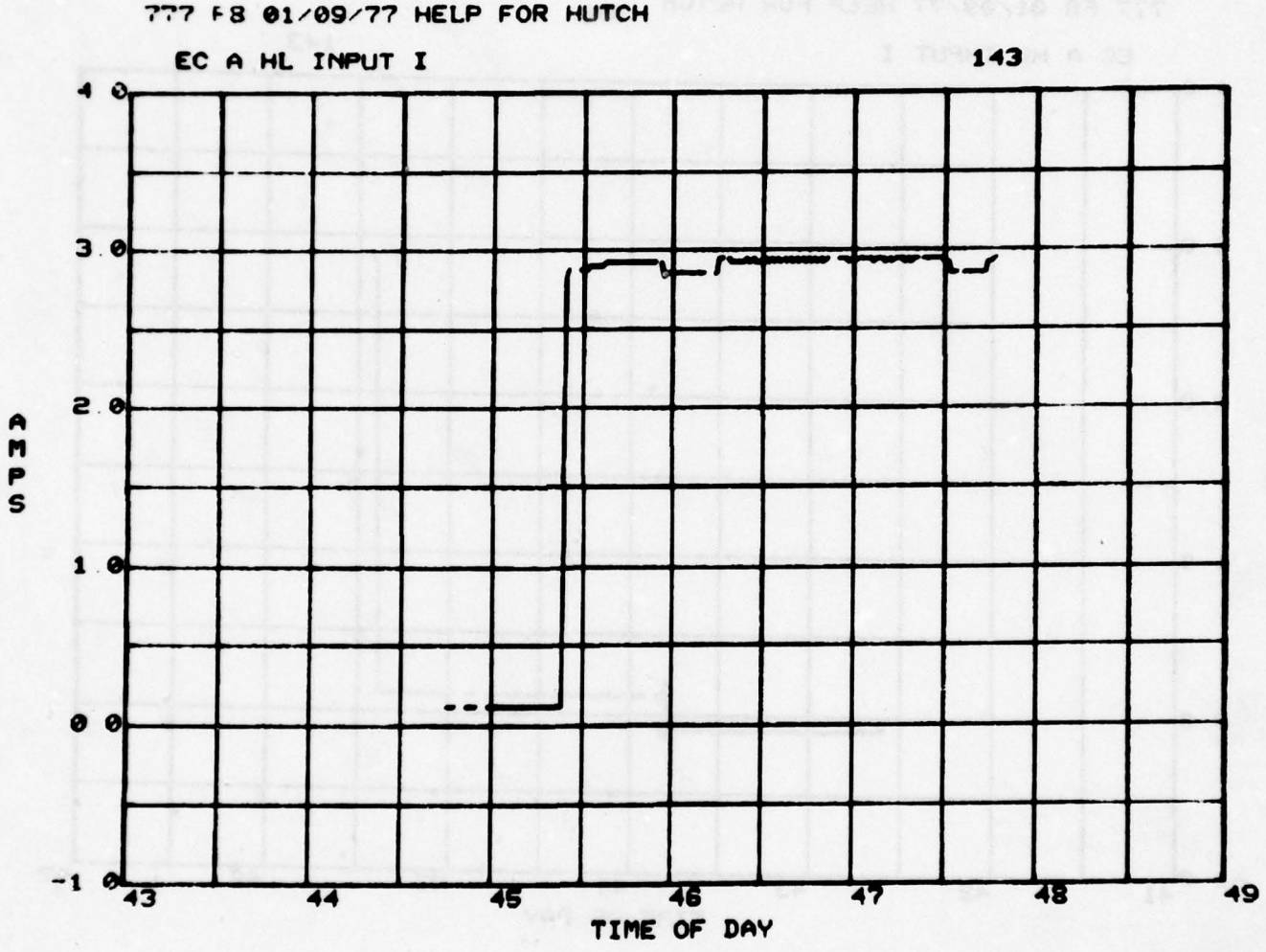
31.0
30.0
VOLTS
2209
2211
2213
2215
2217
2219
2221
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH
EC A HL INPUT I
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4 0
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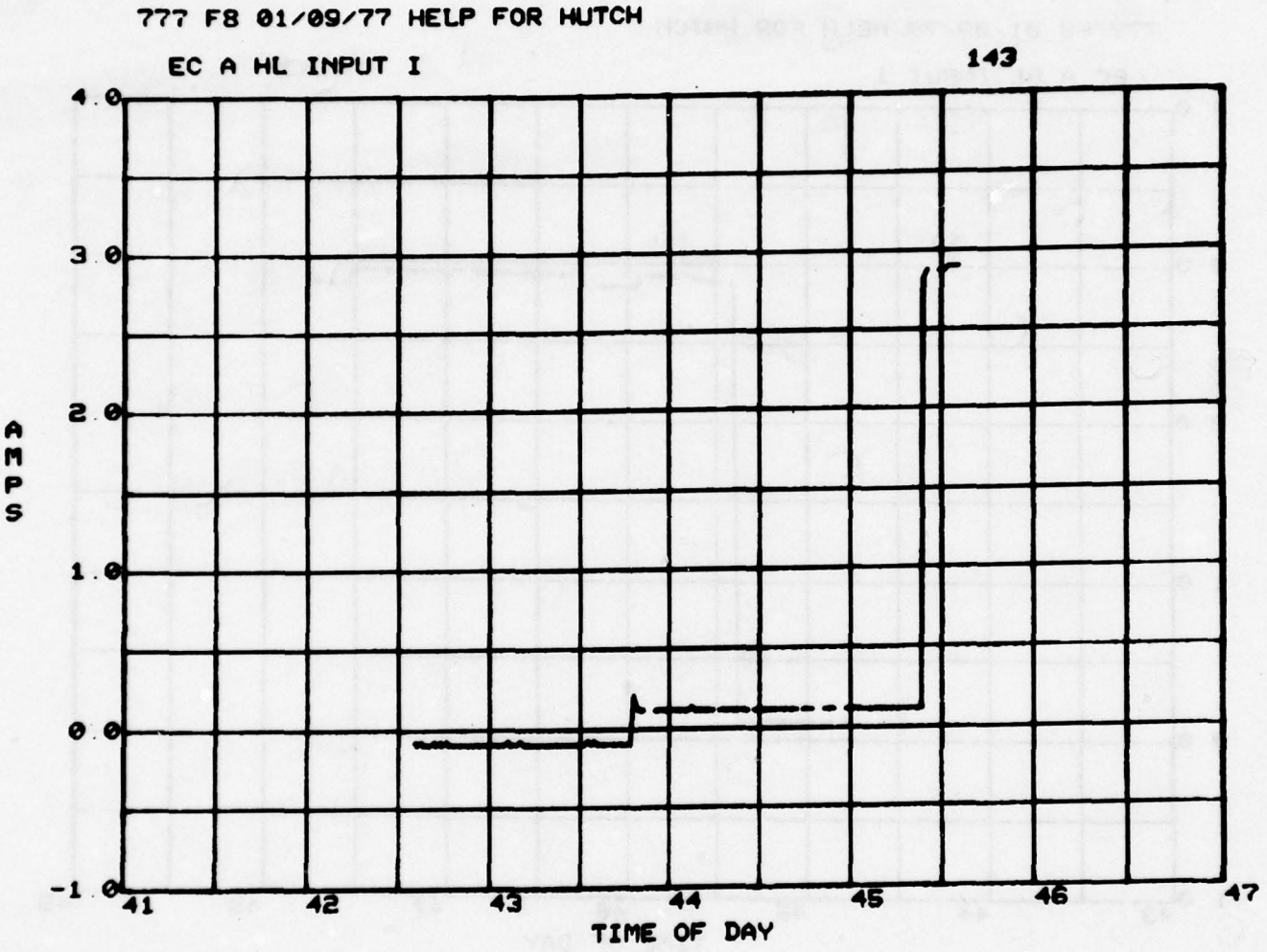
2 0
1 0
0 0
-1 0
AMPS
43
44
45
46
47
48
49
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH
EC A HL INPUT I
143
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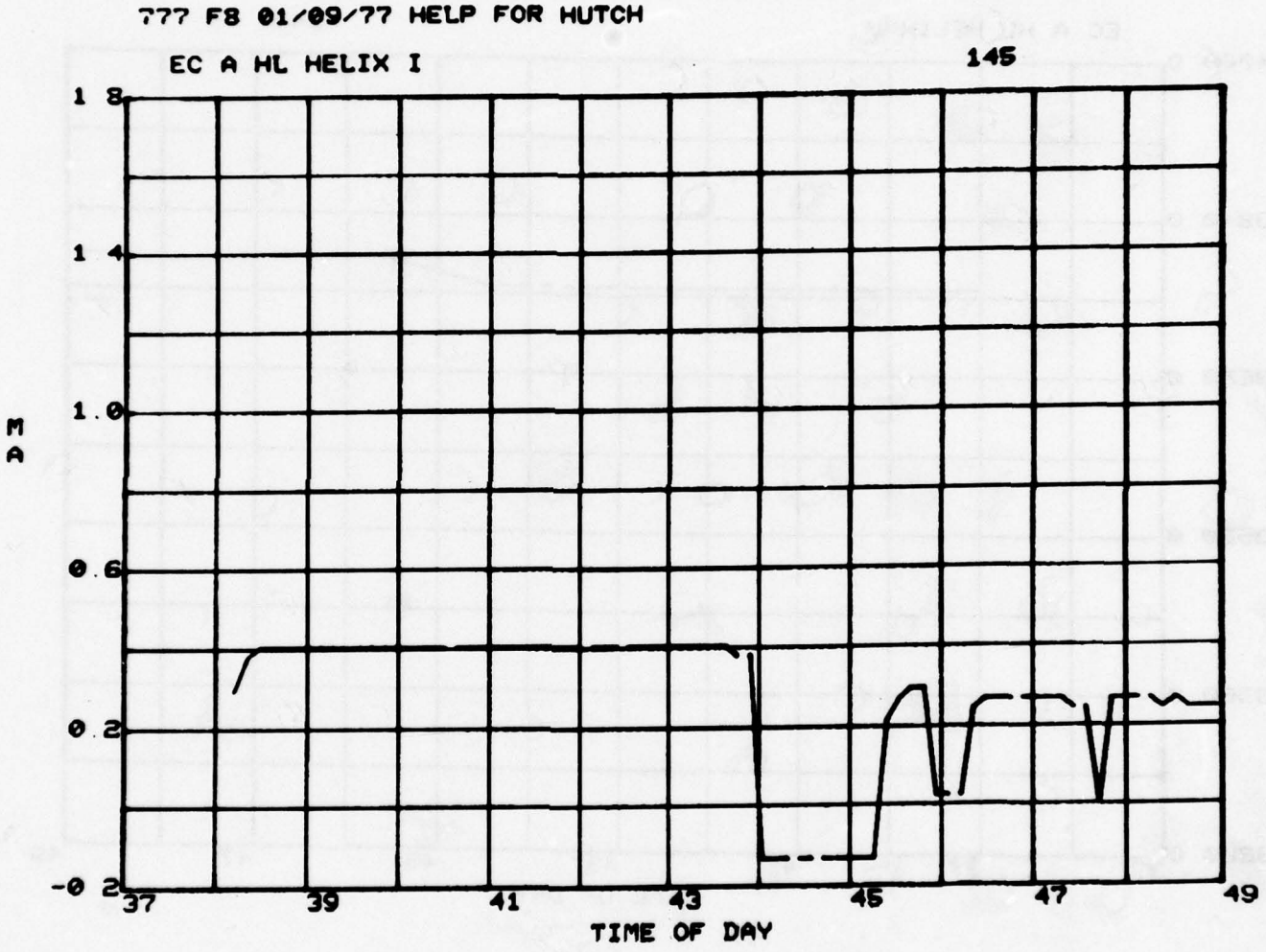
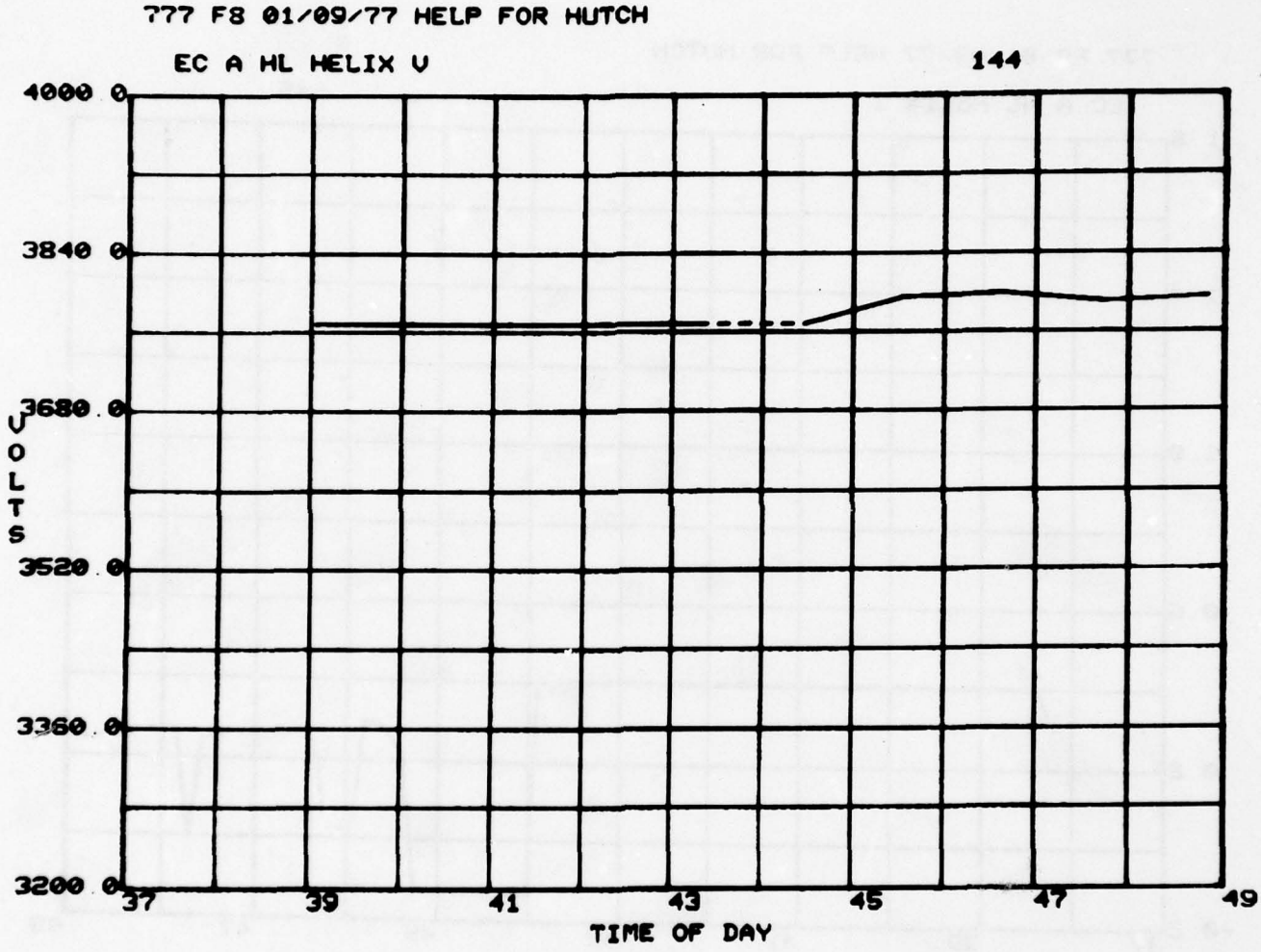
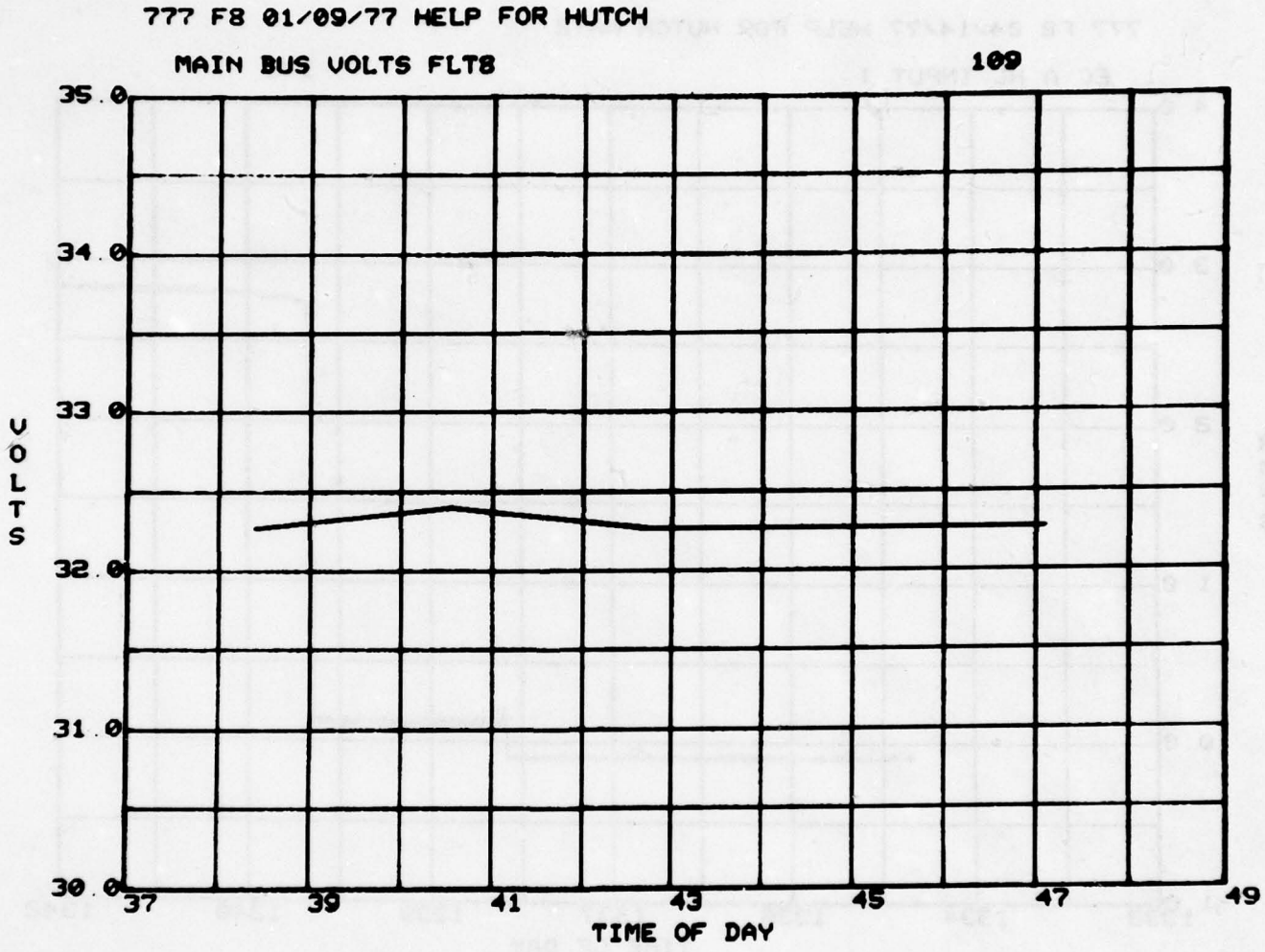
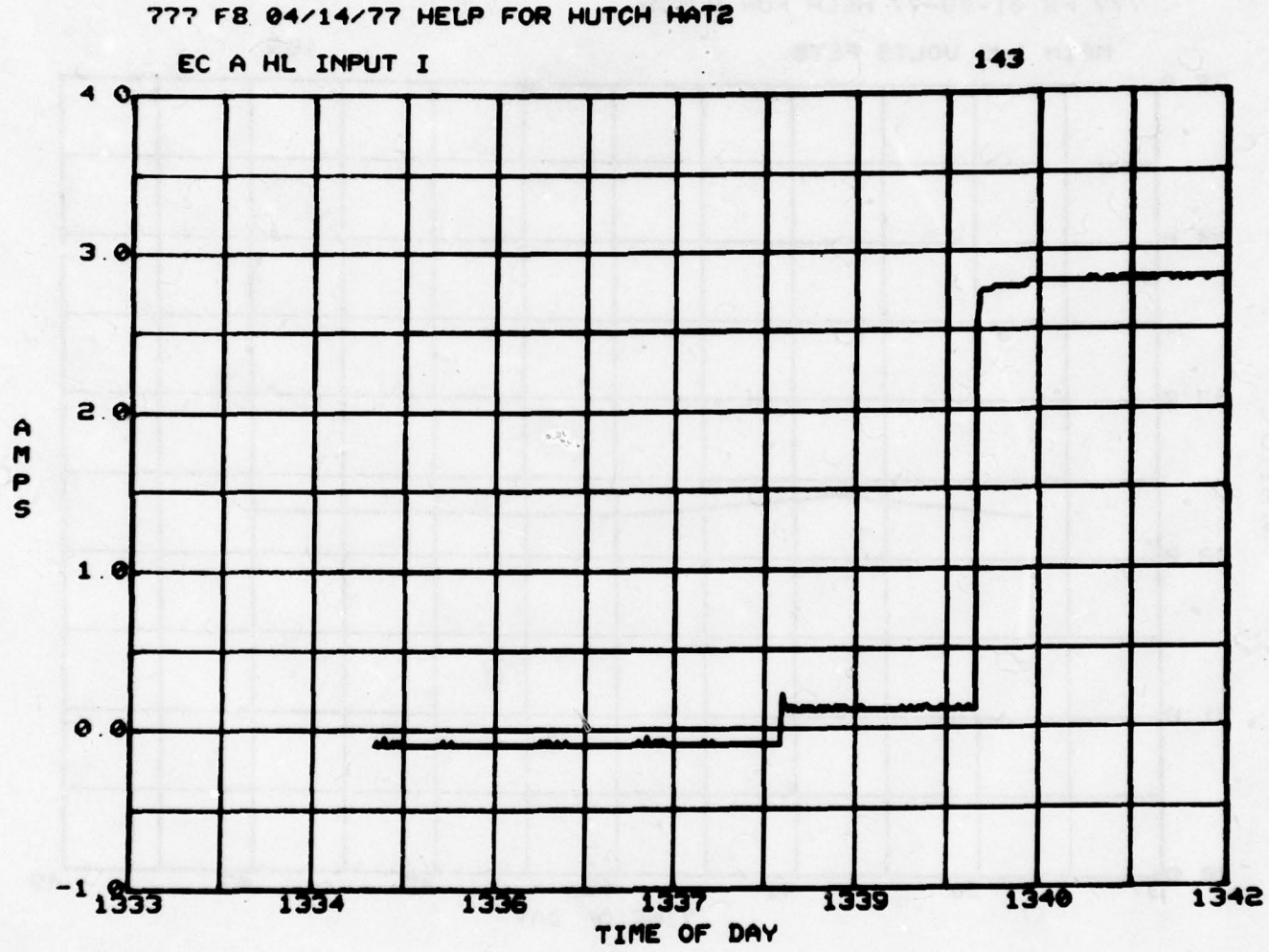
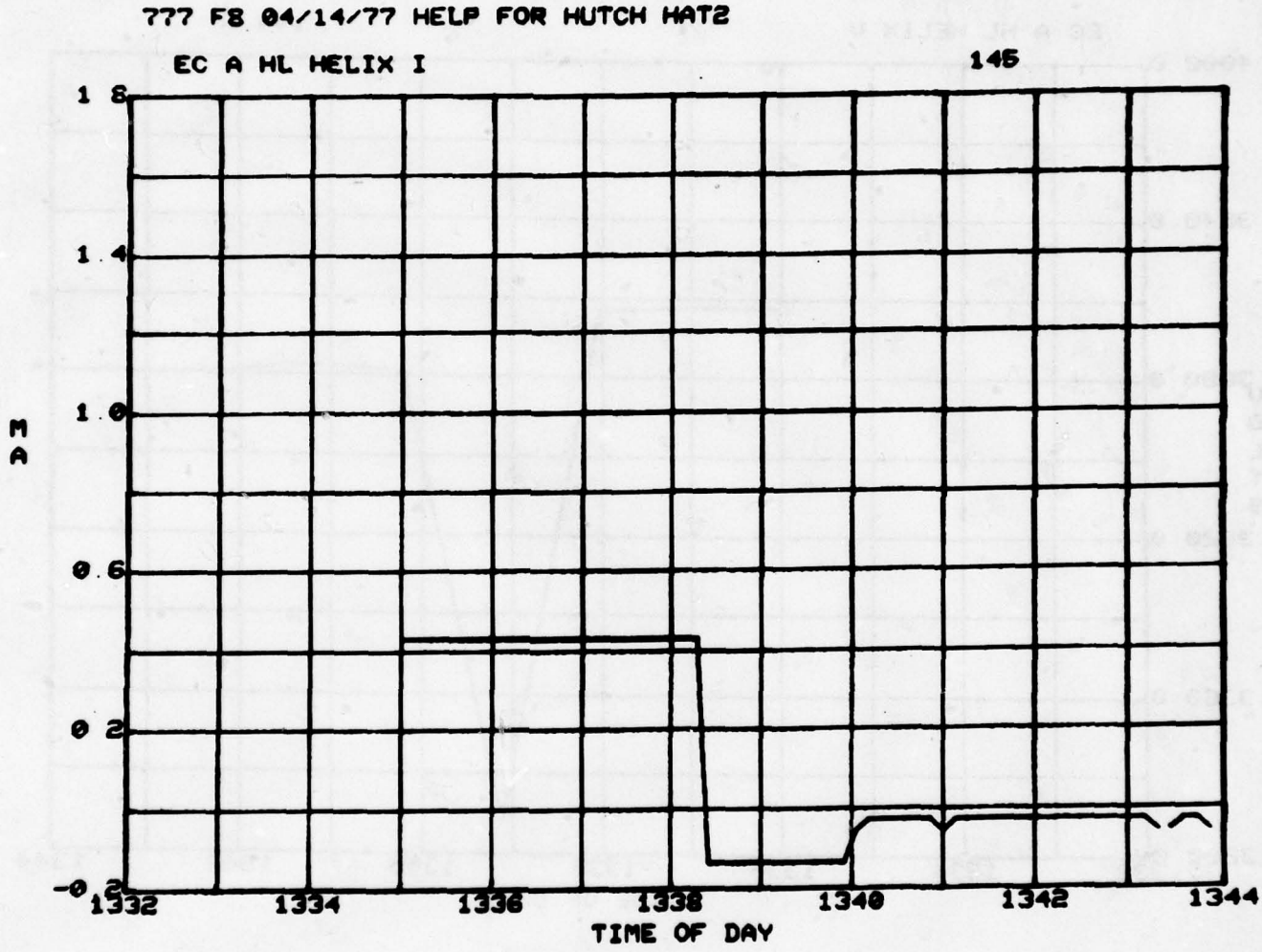
1.0
0.0
-1.0
AMPS
41
42
43
44
45
46
47
TIME OF DAY

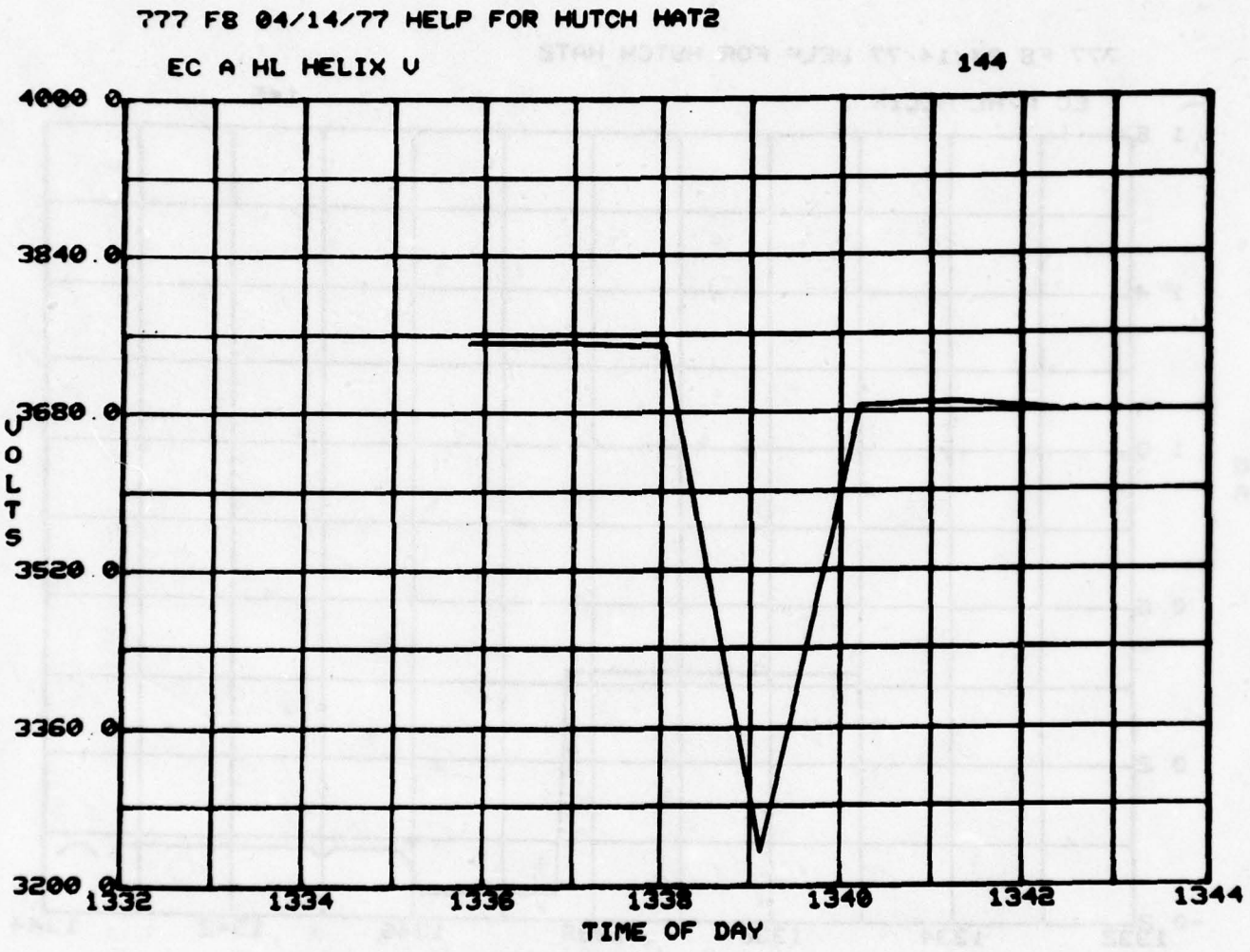

777 F8 01/09/77 HELP FOR HUTCH
EC A HL HELIX I
145
1 8
1 4
1.0
0.6
0.2
-0 2
M
A
37
39
41
43
45
47
49
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH
EC A HL HELIX V
144
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
37
39
41
43
45
47
49
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
37
39
41
43
45
47
49
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
EC A HL INPUT I
143
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1333
1334
1336
1337
1339
1340
1342
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
EC A HL HELIX I
145
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
1332
1334
1336
1338
1340
1342
1344
TIME OF DAY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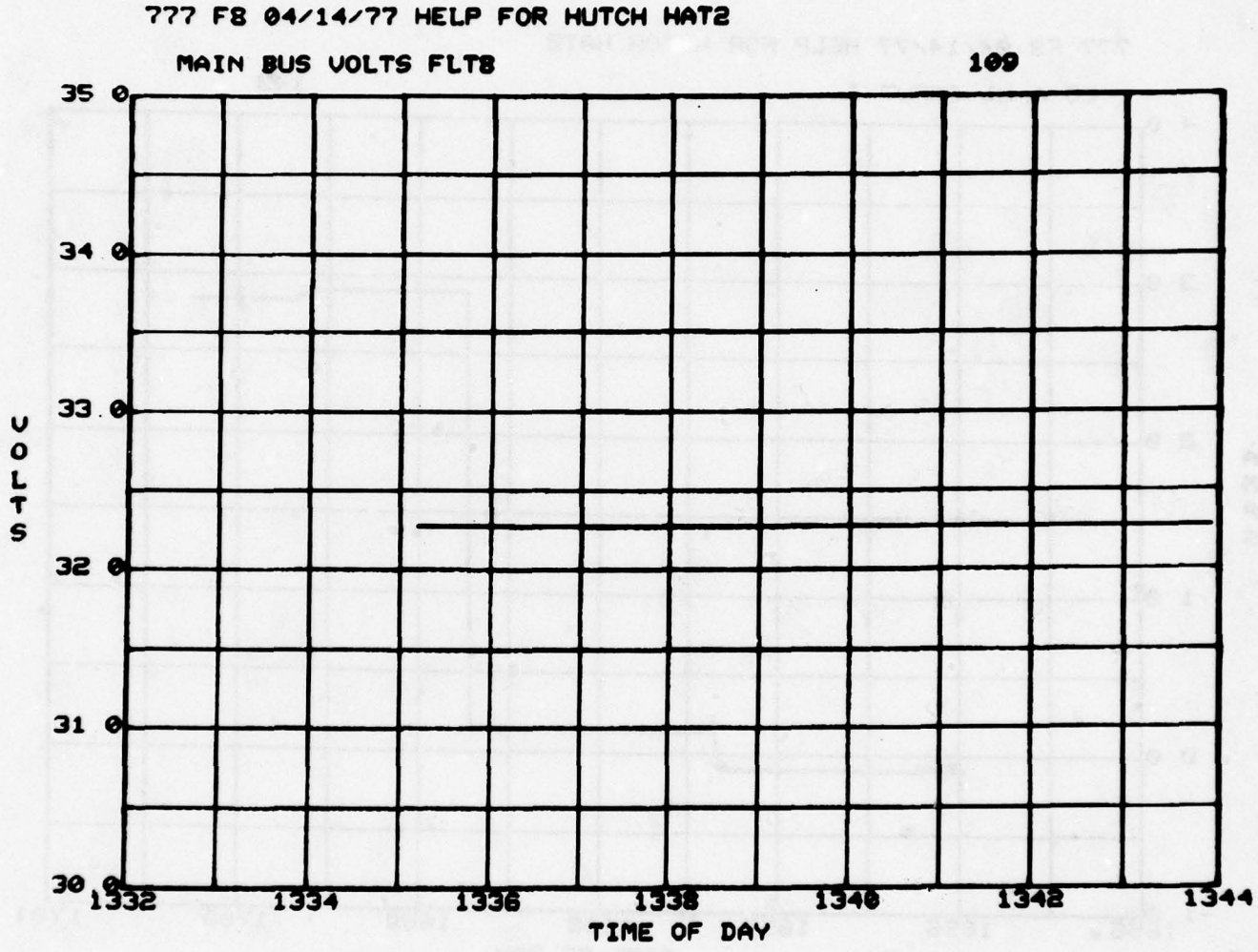
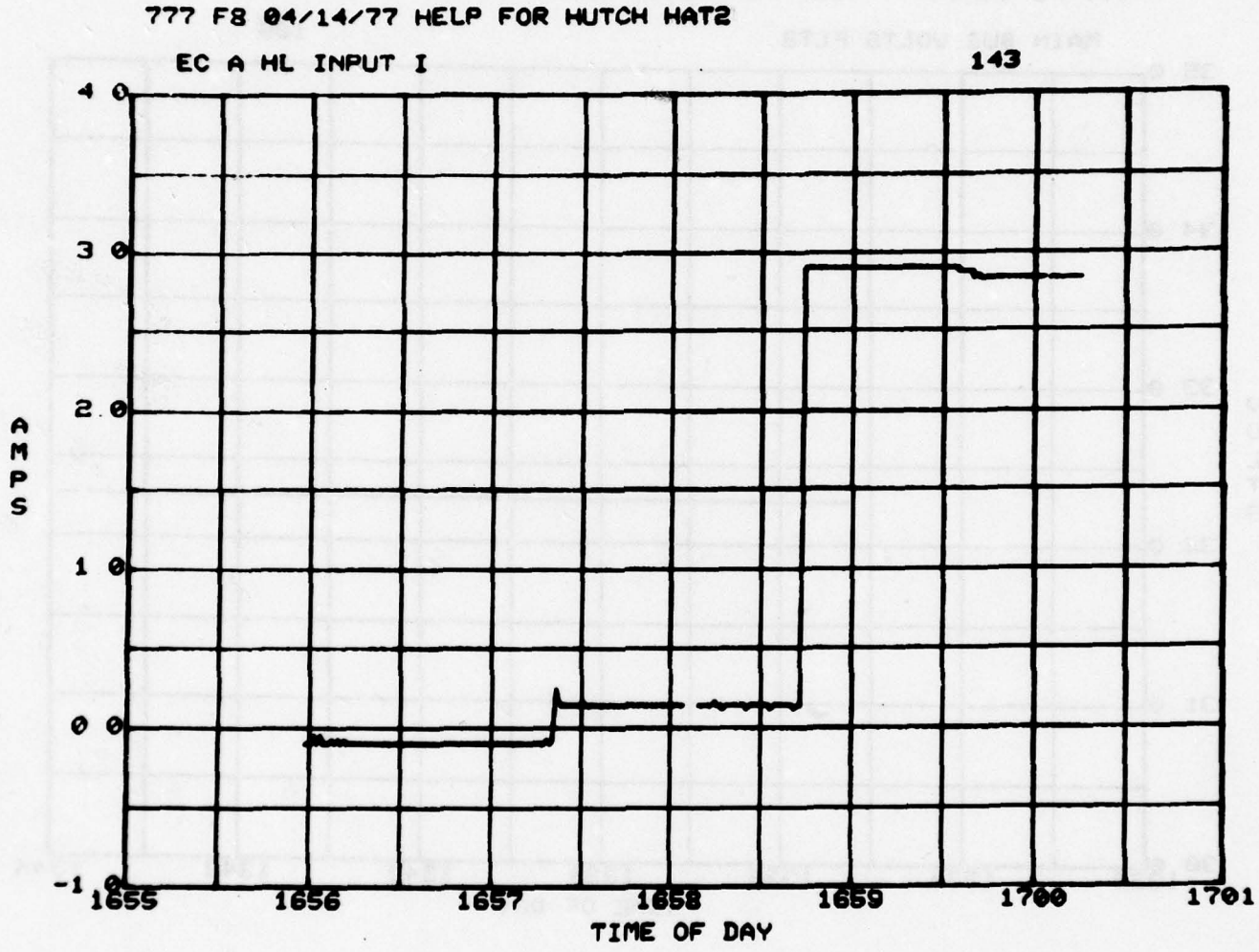
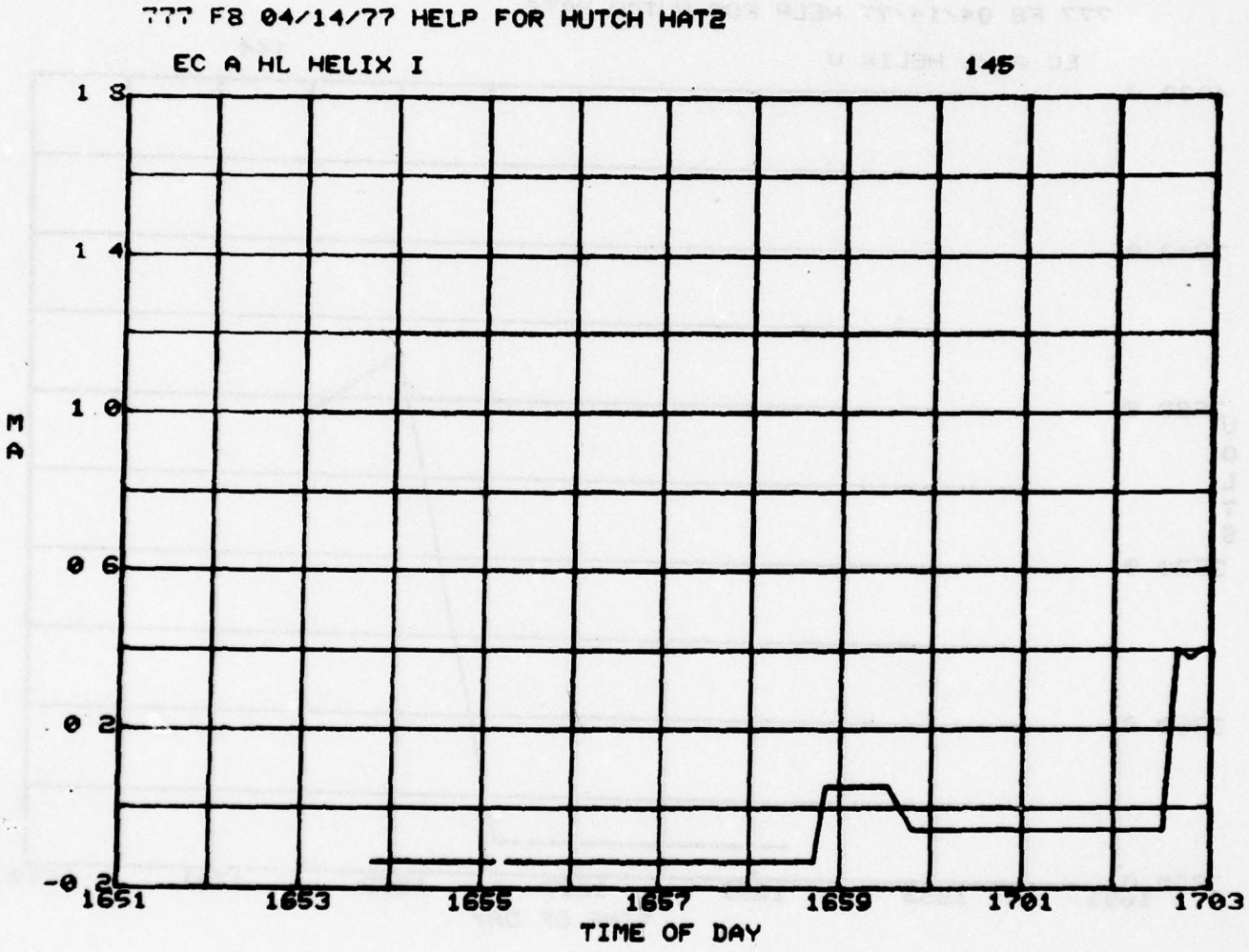
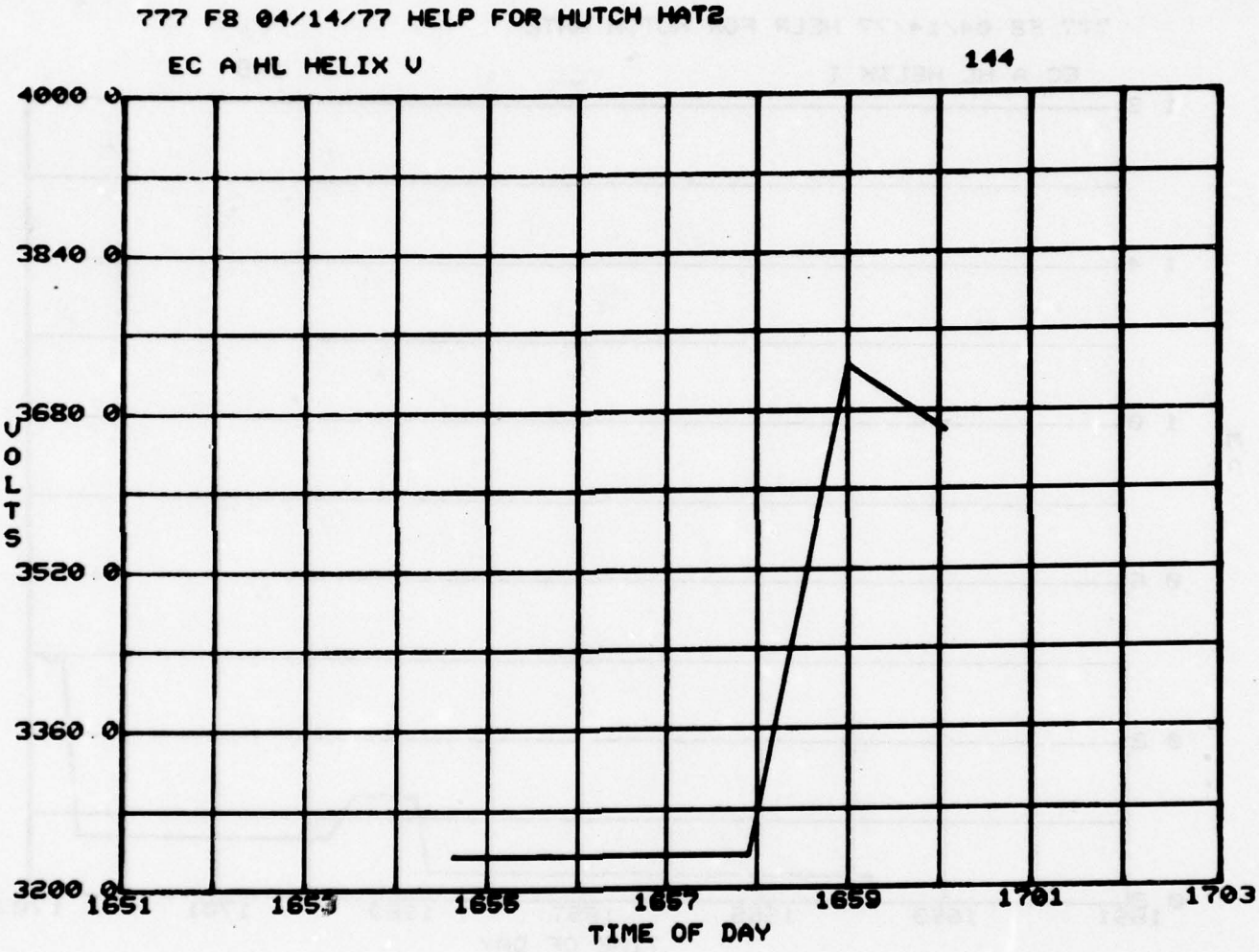
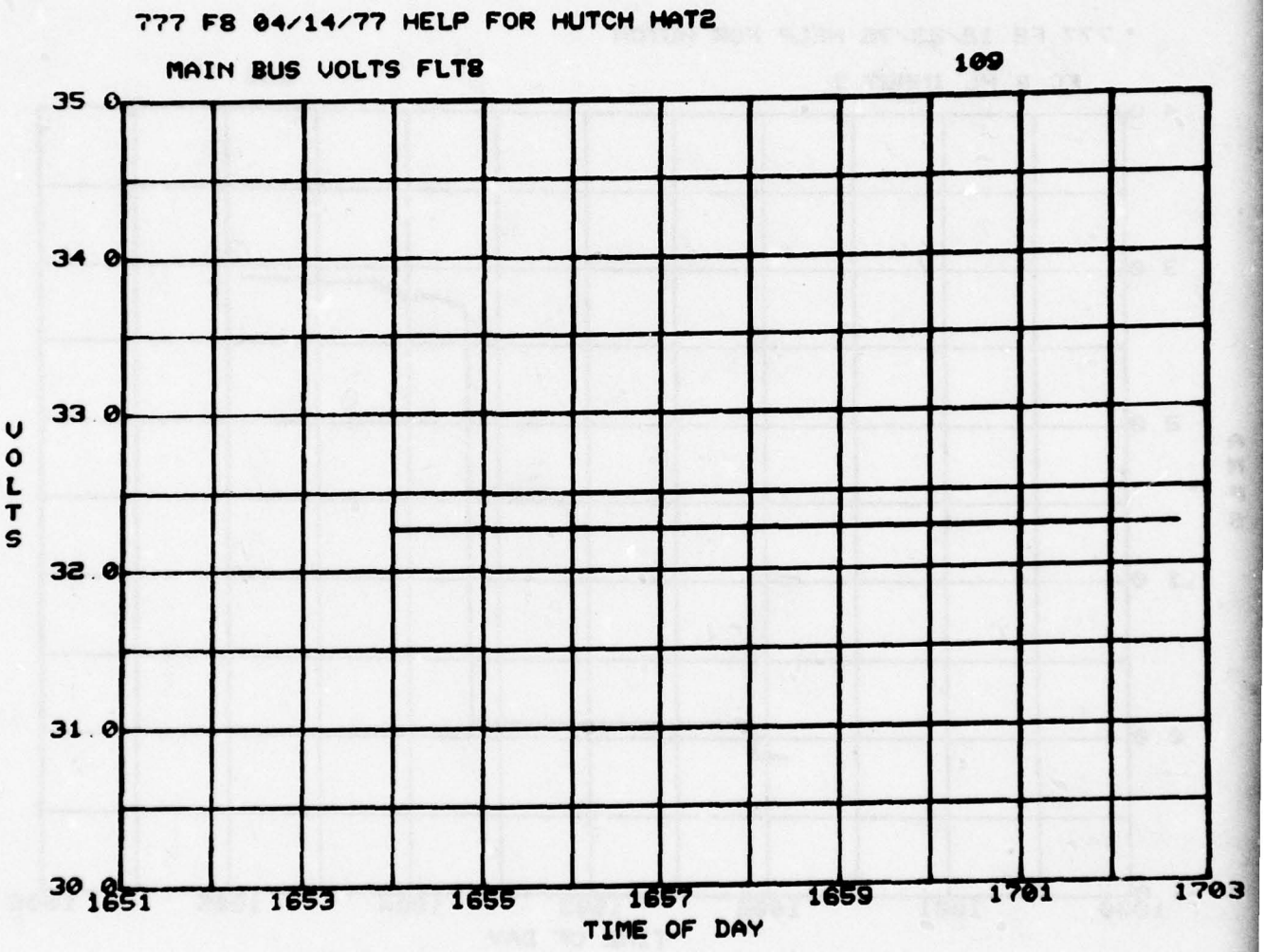
EC A HL HELIX V
144
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1332
1334
1336
1338
1340
1342
1344
TIME OF DAY

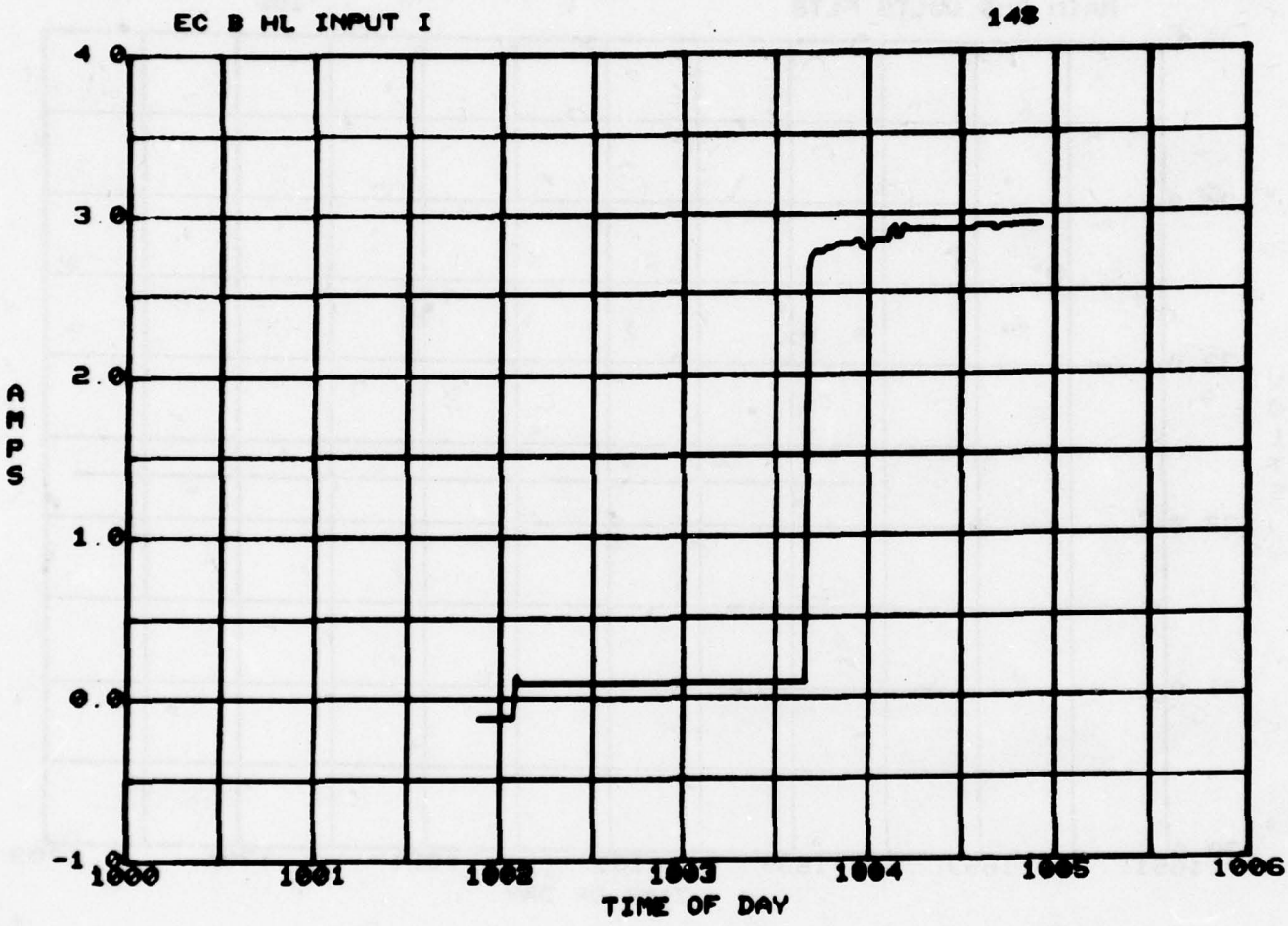

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
1332
1334
1336
1338
1340
1342
1344
TIME OF DAY

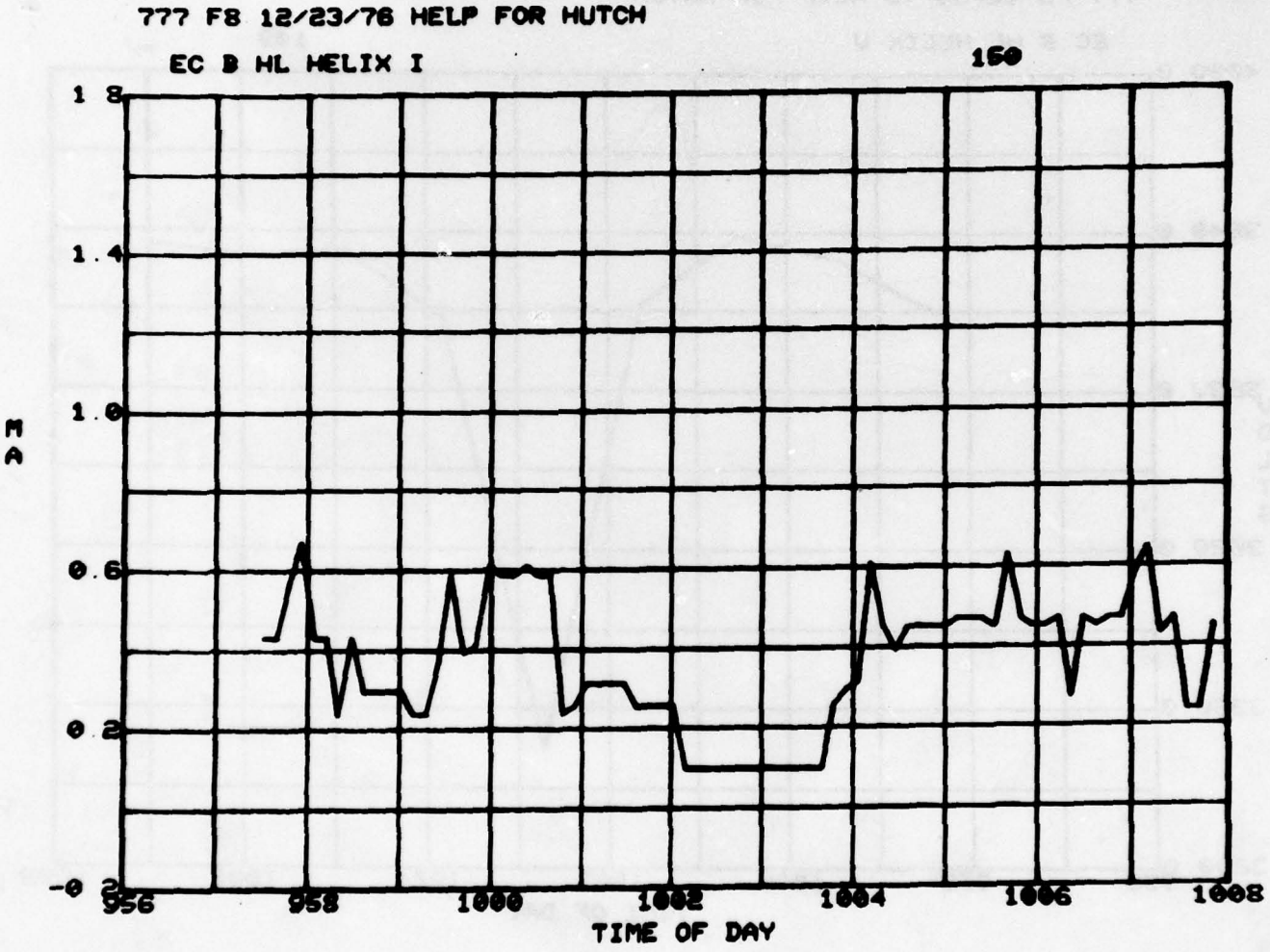

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC A HL INPUT I
143
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
1655
1656
1657
1658
1659
1700
1701
TIME OF DAY

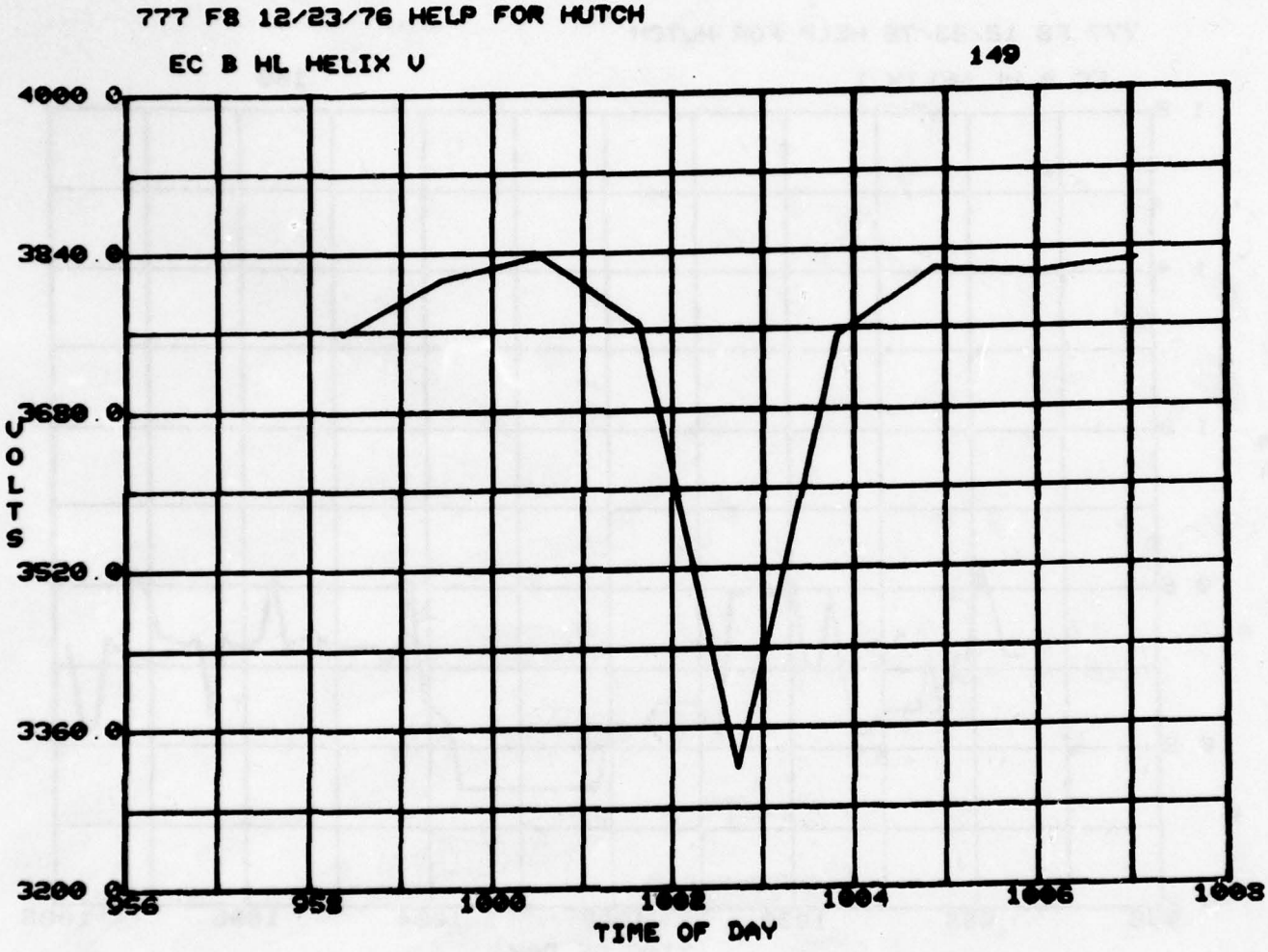

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC A HL HELIX I
145
1 8
1 4
1 0
0 6
0 2
-0 2
MA
1651
1653
1655
1657
1659
1701
1703
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
EC A HL HELIX V
144
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
1651
1653
1655
1657
1659
1701
1703
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1651
1653
1655
1657
1659
1701
1703
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1000
1001
1002
1003
1004
1005
1006
TIME OF DAY


777 F8 12/23/78 HELP FOR HUTCH
EC B HL HELIX I
150
1 8
1 4
1 0
0 6
0 2
-0 2
MA
956
958
1000
1002
1004
1006
1008
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
EC B HL HELIX V
149
4000.0
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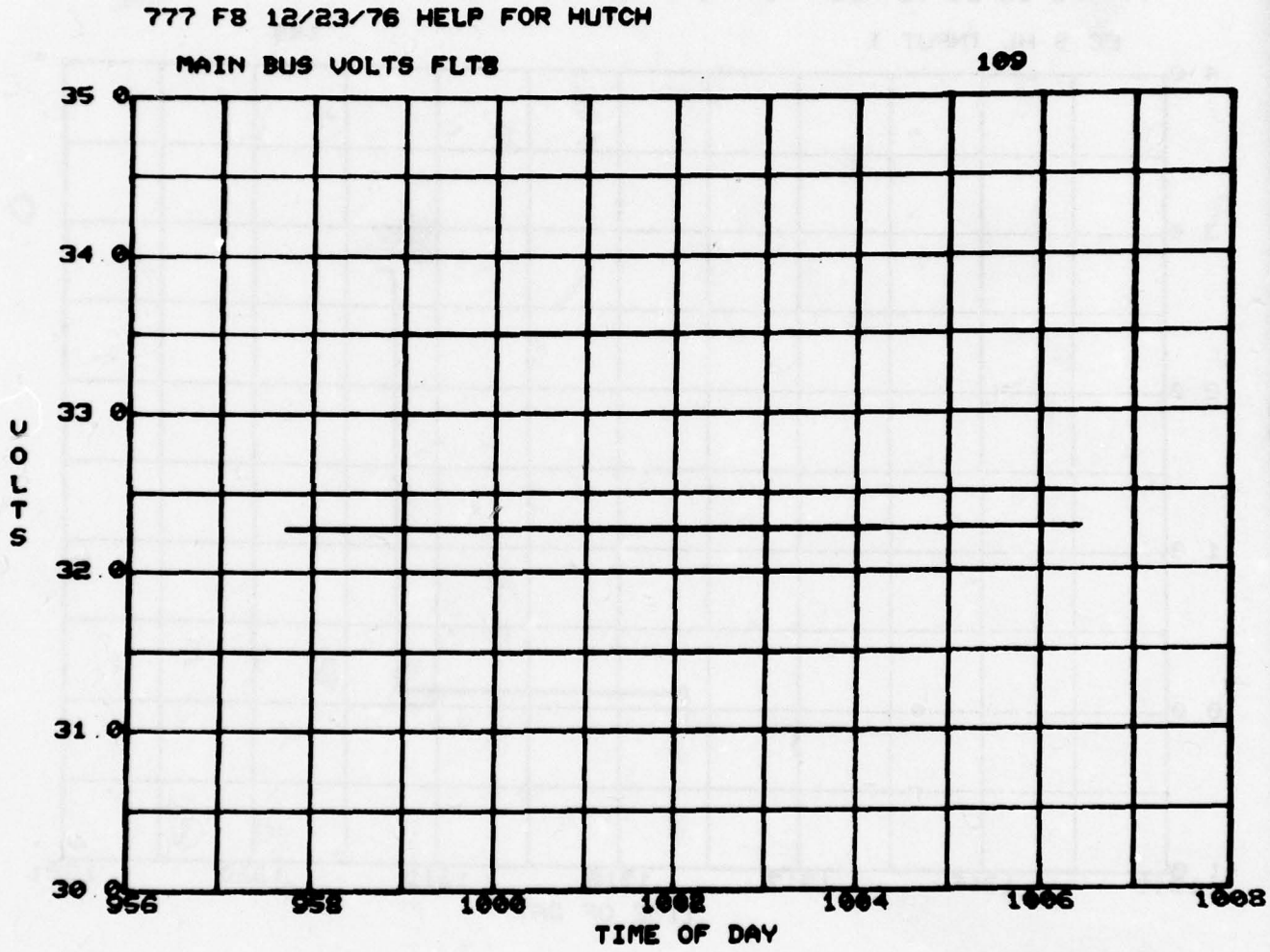
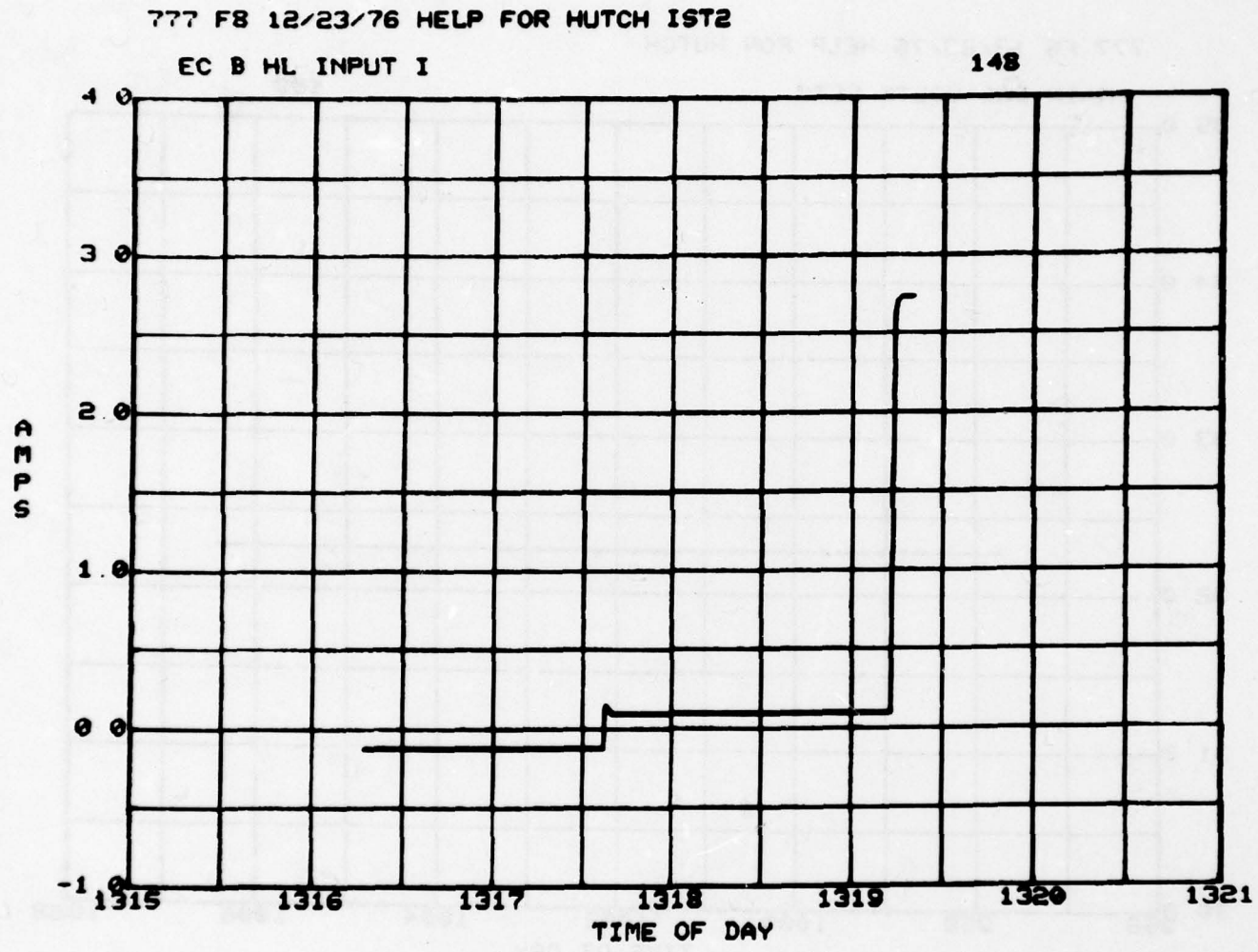
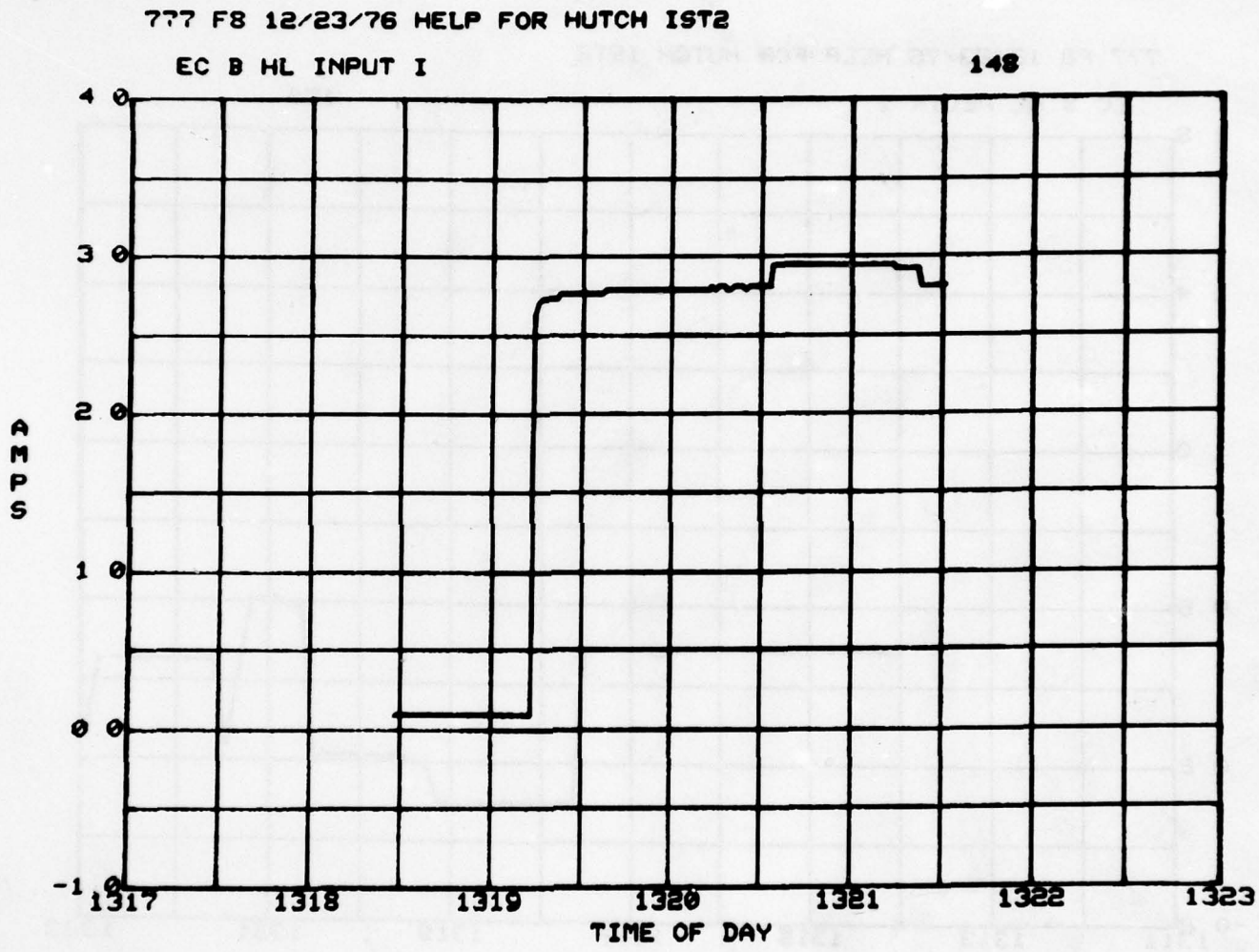
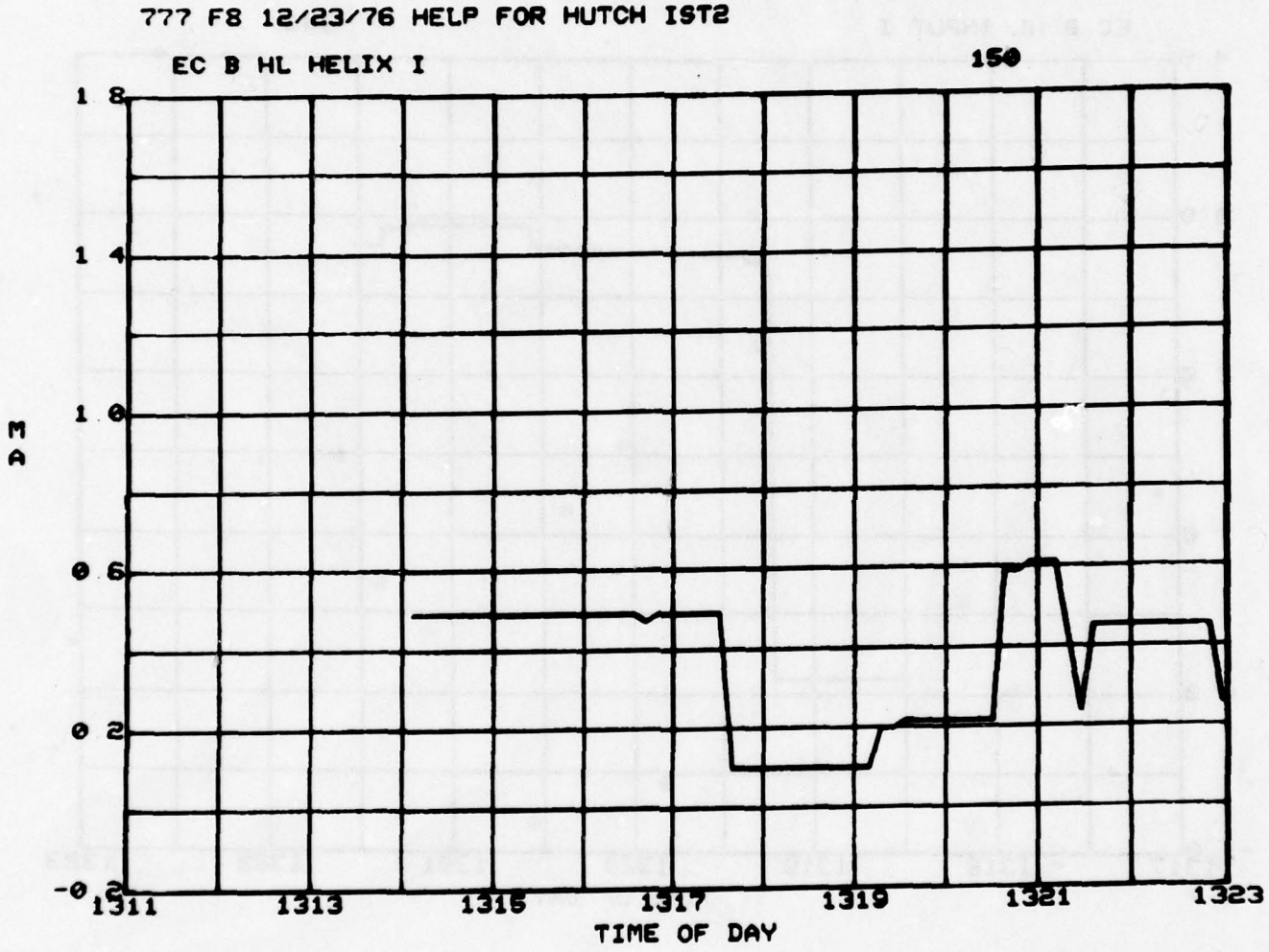
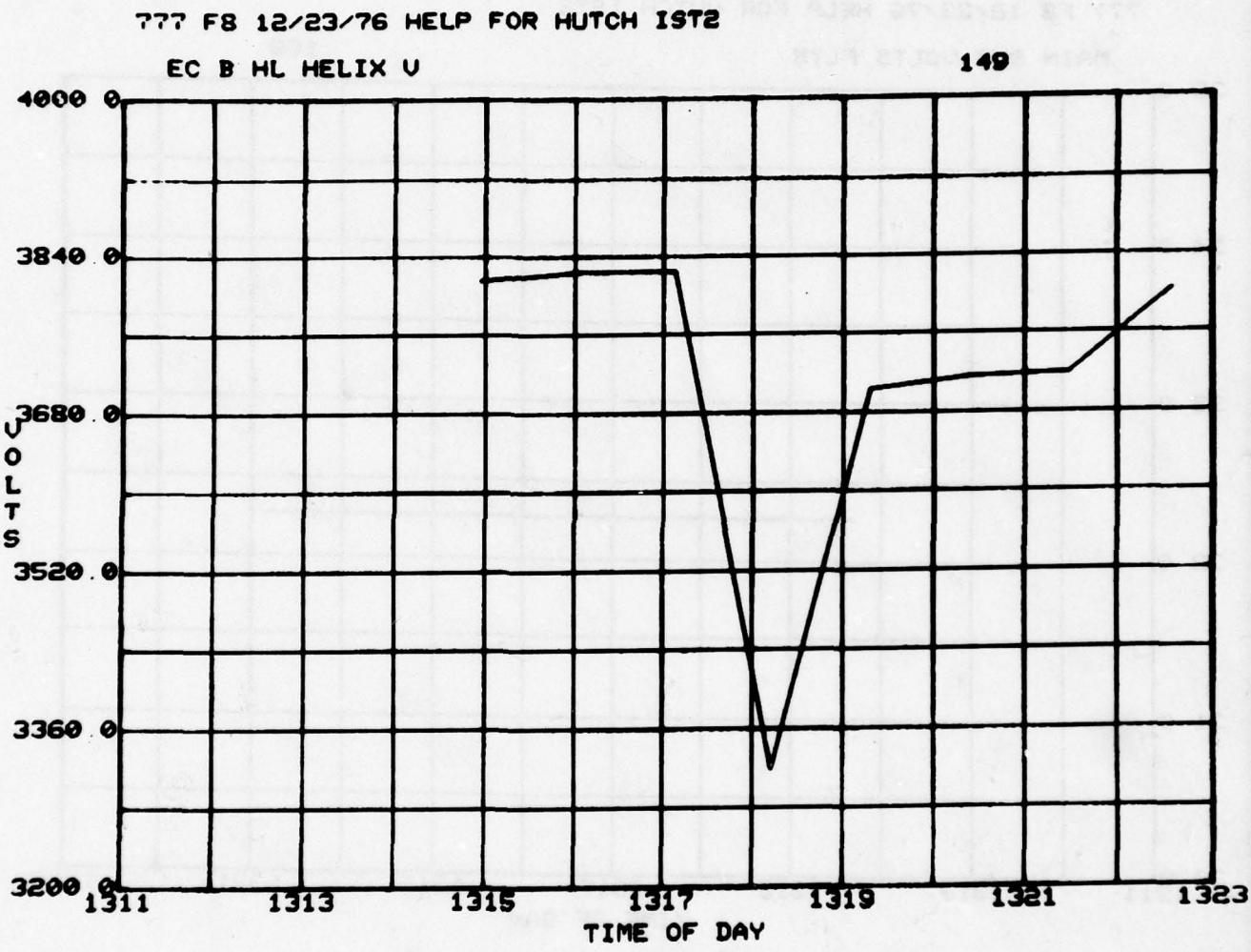
3520.0
3360.0
3200.0
VOLTS
956
958
1000
1002
1004
1006
1008
TIME OF DAY

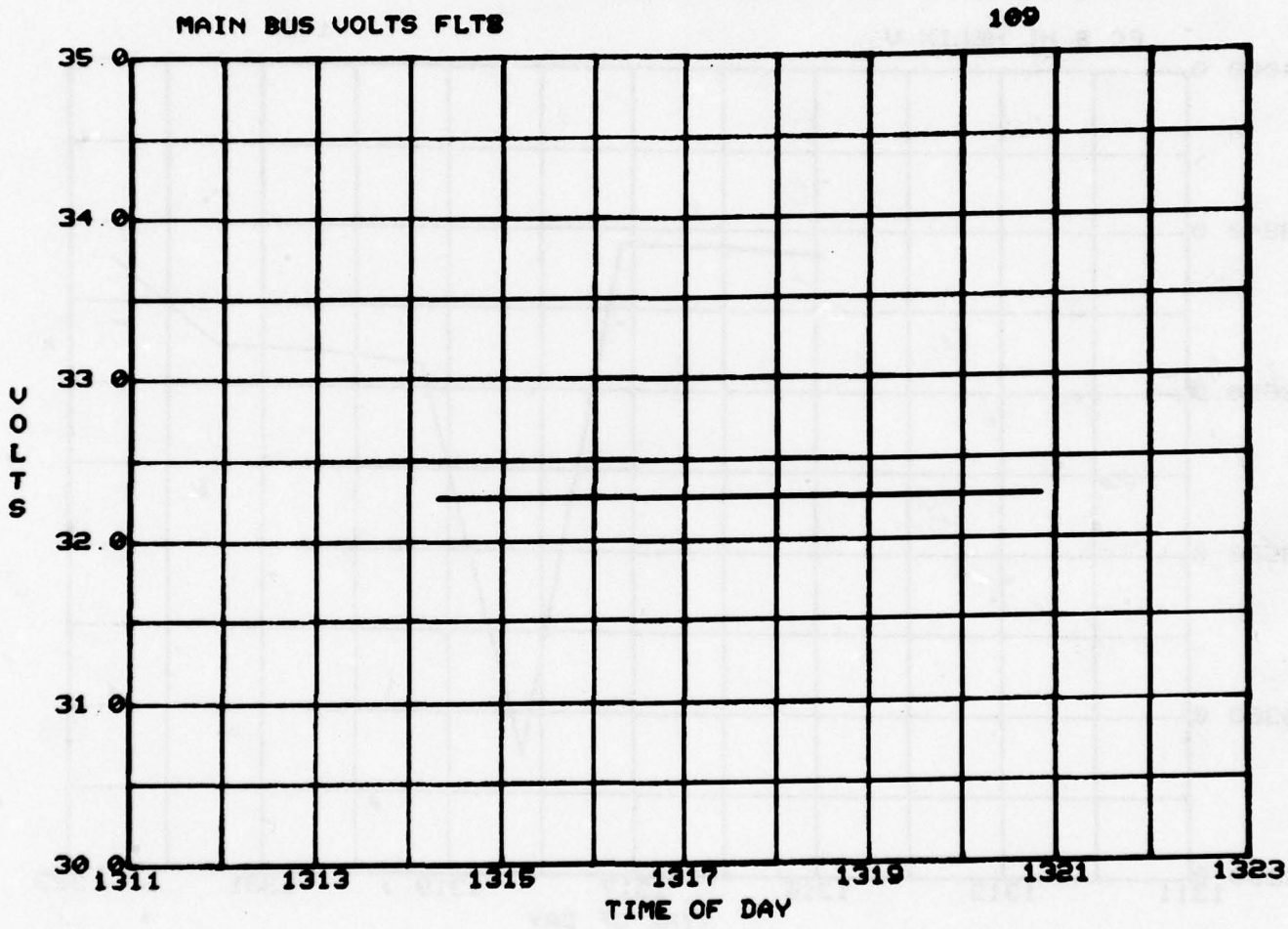

777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
956
958
1000
1002
1004
1006
1008
TIME OF DAY

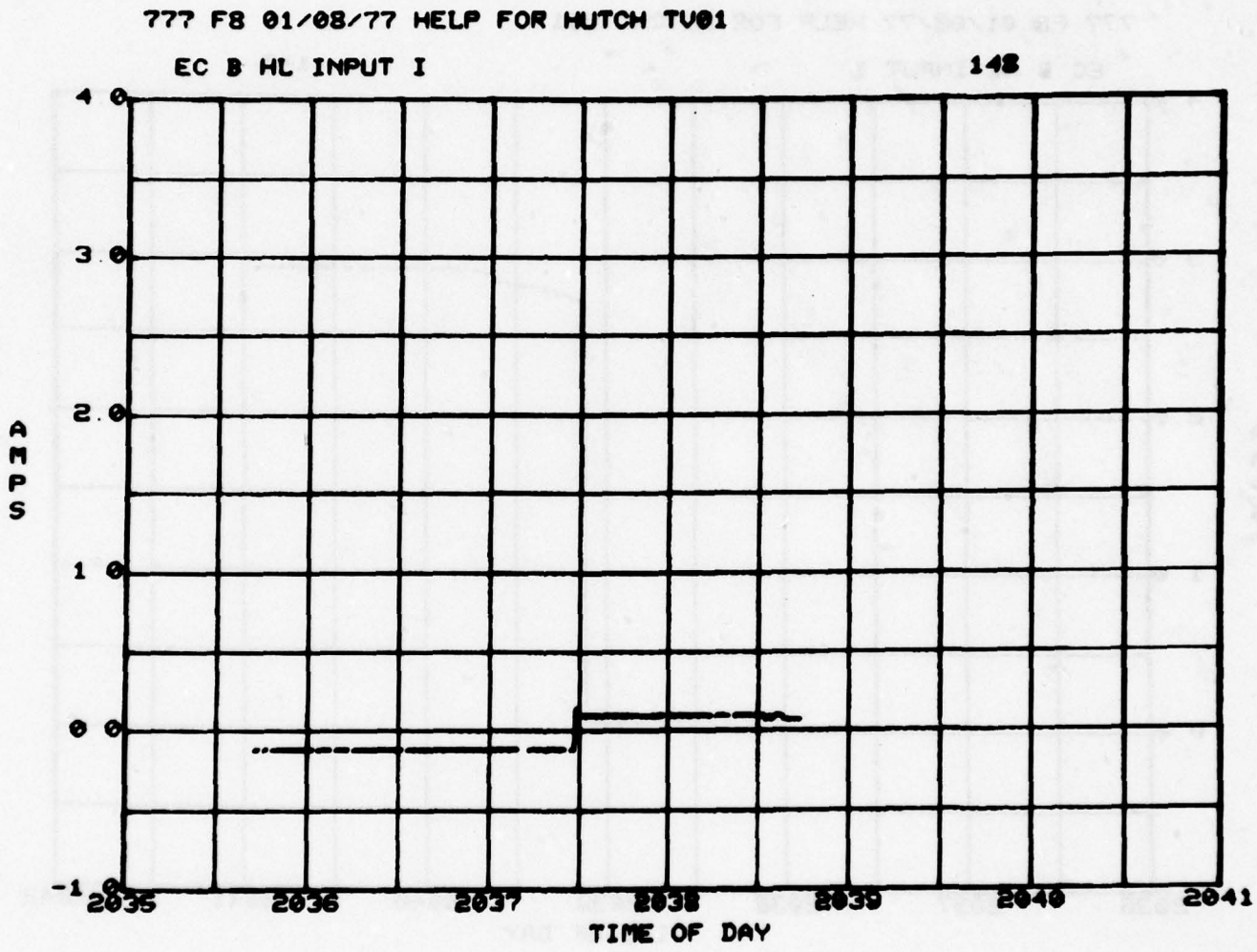

777 F8 12/23/76 HELP FOR HUTCH IST2
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1315
1316
1317
1318
1319
1320
1321
TIME OF DAY

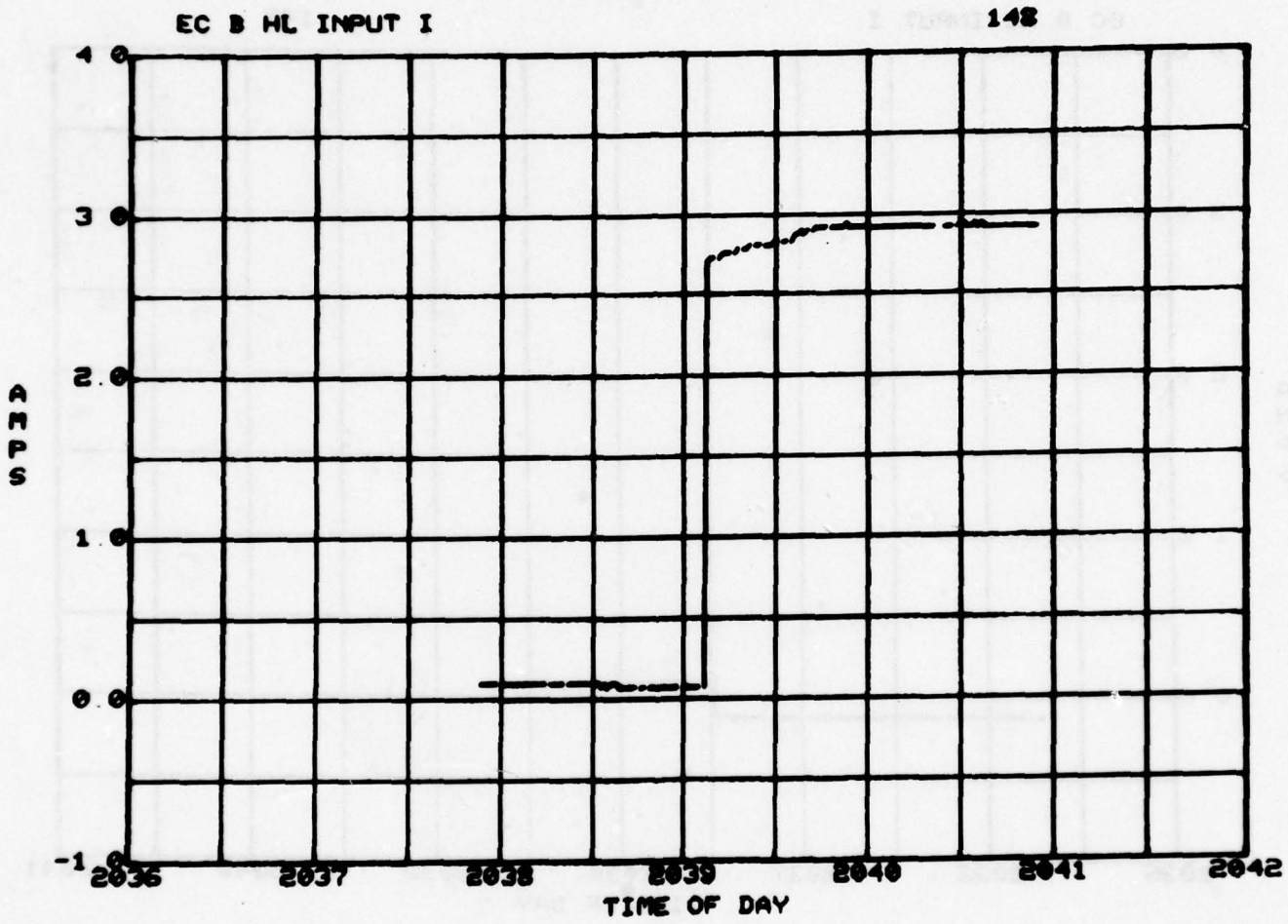

777 F8 12/23/76 HELP FOR HUTCH IST2
EC B HL INPUT I
148
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
1317
1318
1319
1320
1321
1322
1323
TIME OF DAY

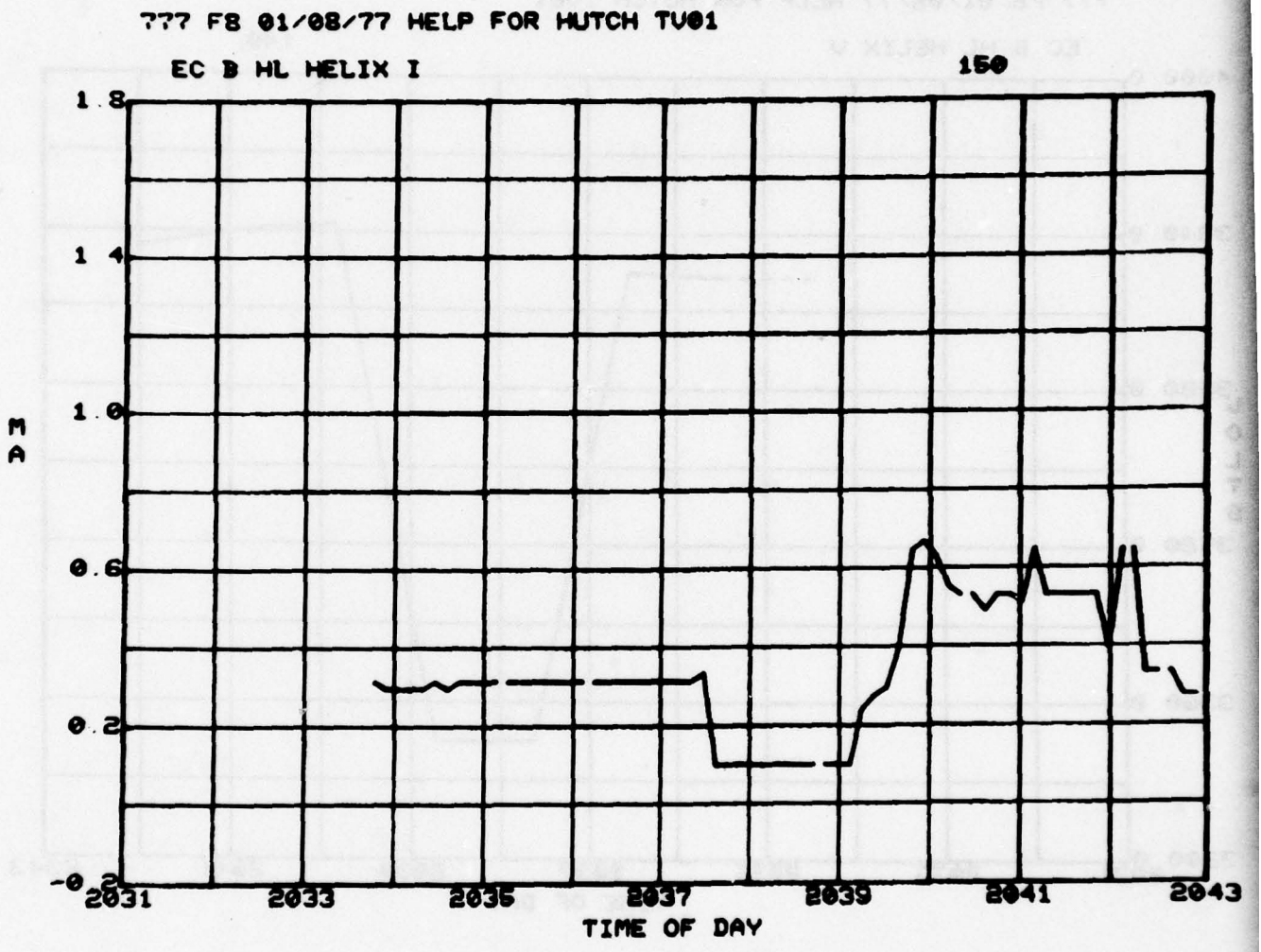

777 F8 12/23/76 HELP FOR HUTCH IST2
EC B HL HELIX I
150
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
1311
1313
1315
1317
1319
1321
1323
TIME OF DAY

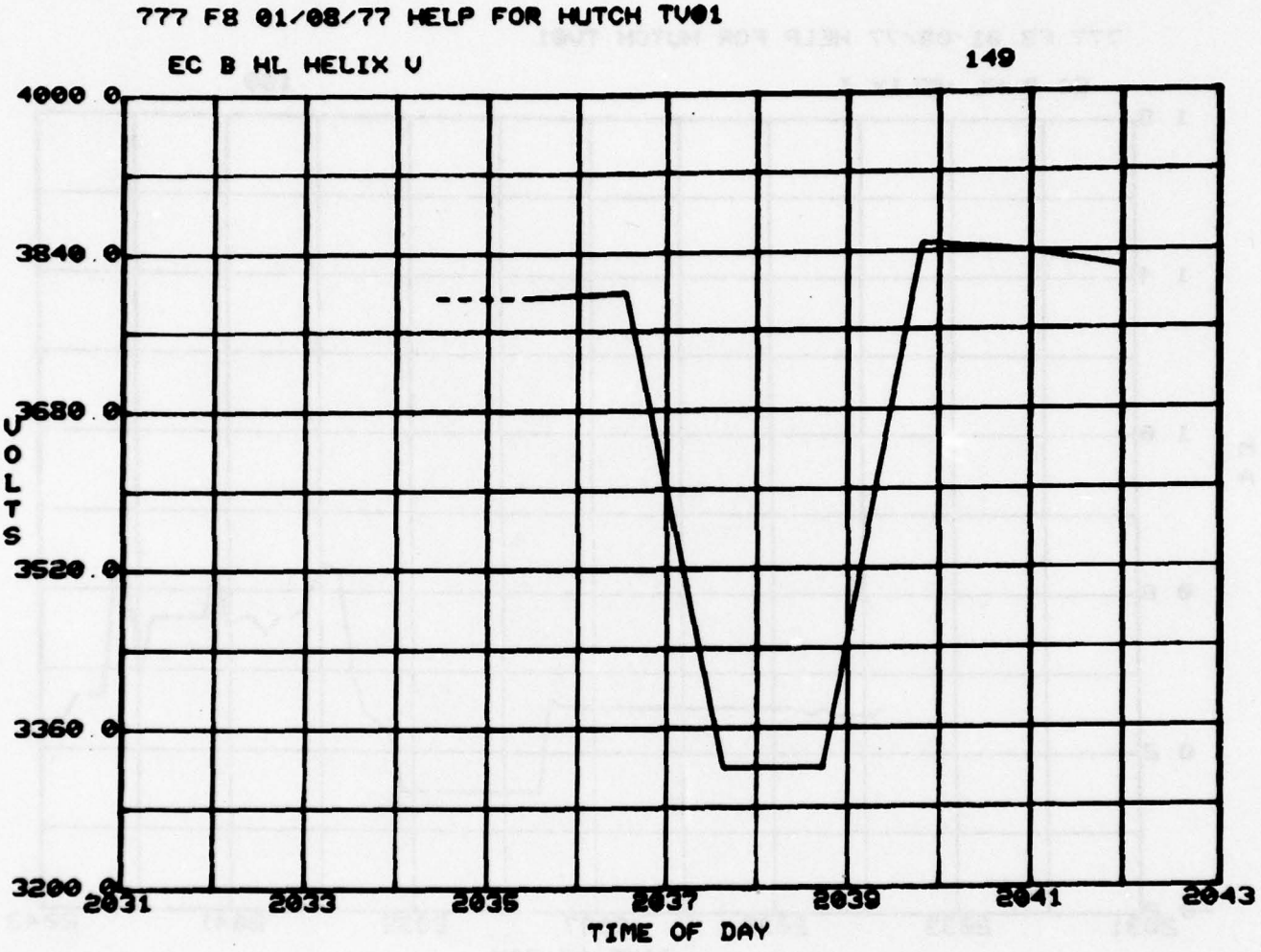

777 F8 12/23/76 HELP FOR HUTCH IST2
EC B HL HELIX V
149
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1311
1313
1315
1317
1319
1321
1323
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH IST2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1311
1313
1315
1317
1319
1321
1323
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
2035
2036
2037
2038
2039
2040
2041
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
2036
2037
2038
2039
2040
2041
2042
TIME OF DAY


??? F8 01/08/77 HELP FOR HUTCH TV01
EC B HL HELIX I
150
1.8
1.4
1.0
0.6
0.2
-0.2
MA
2031
2033
2035
2037
2039
2041
2043
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
EC B HL HELIX V
149
4000.0
3840.0
3680.0
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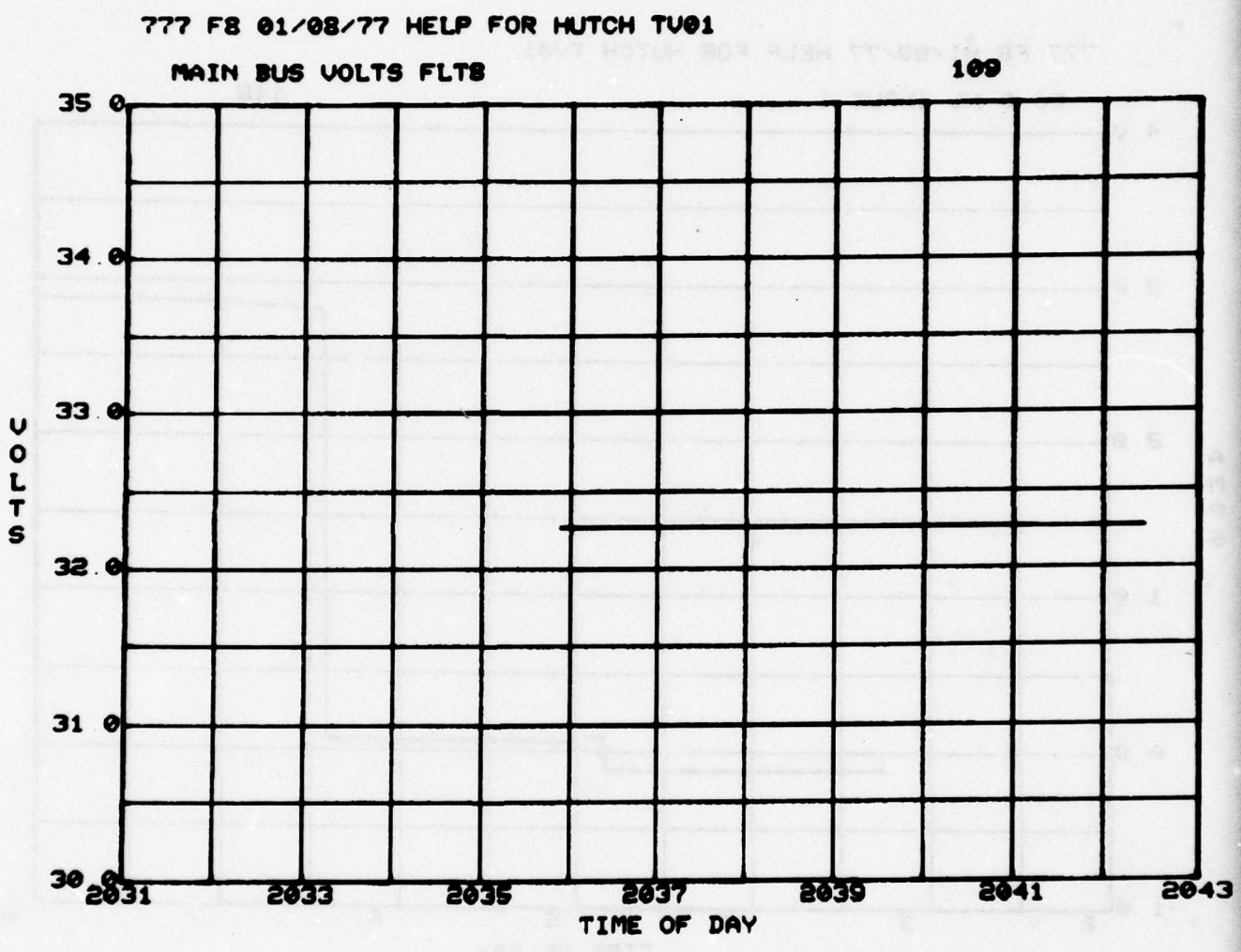
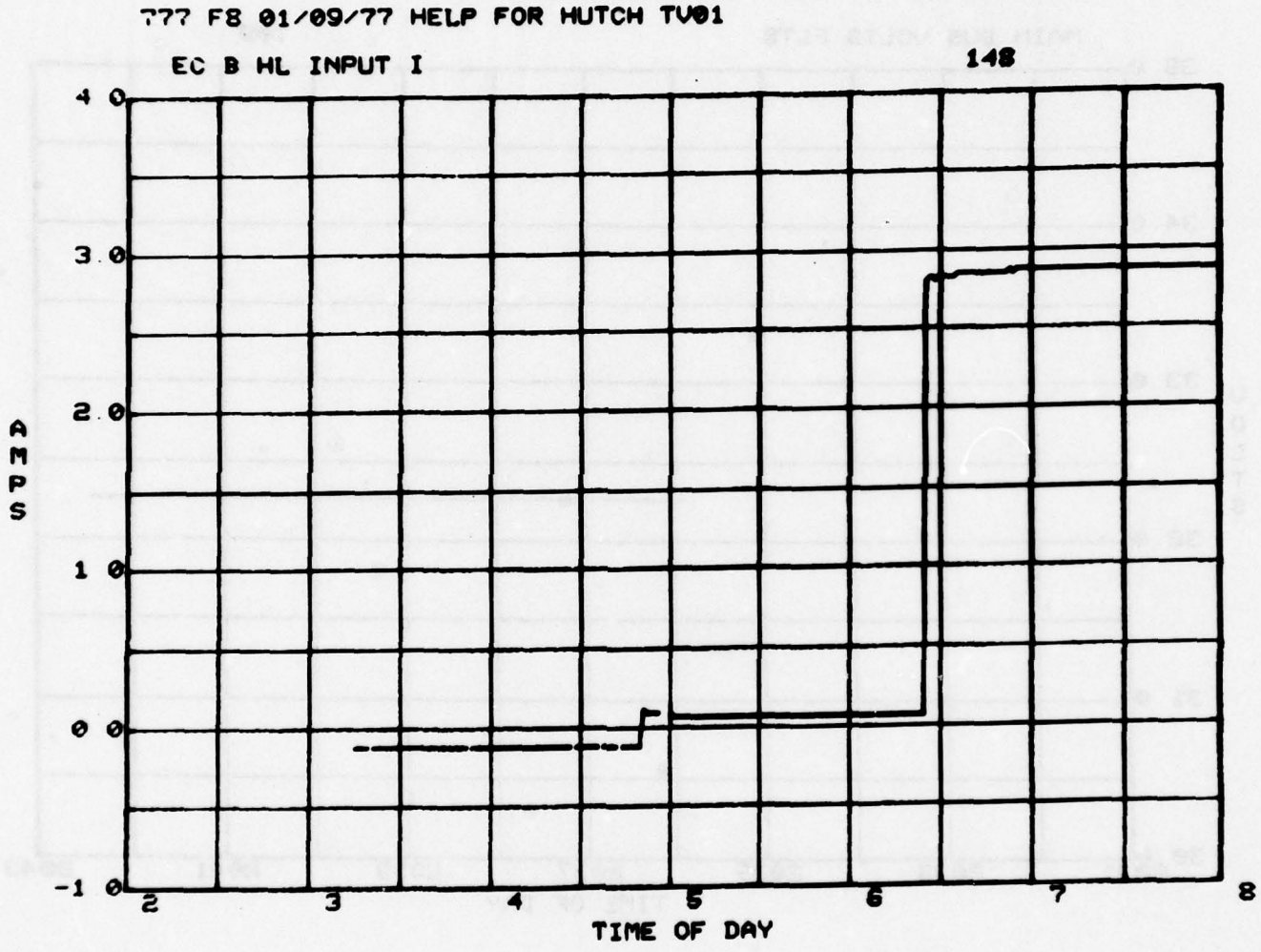
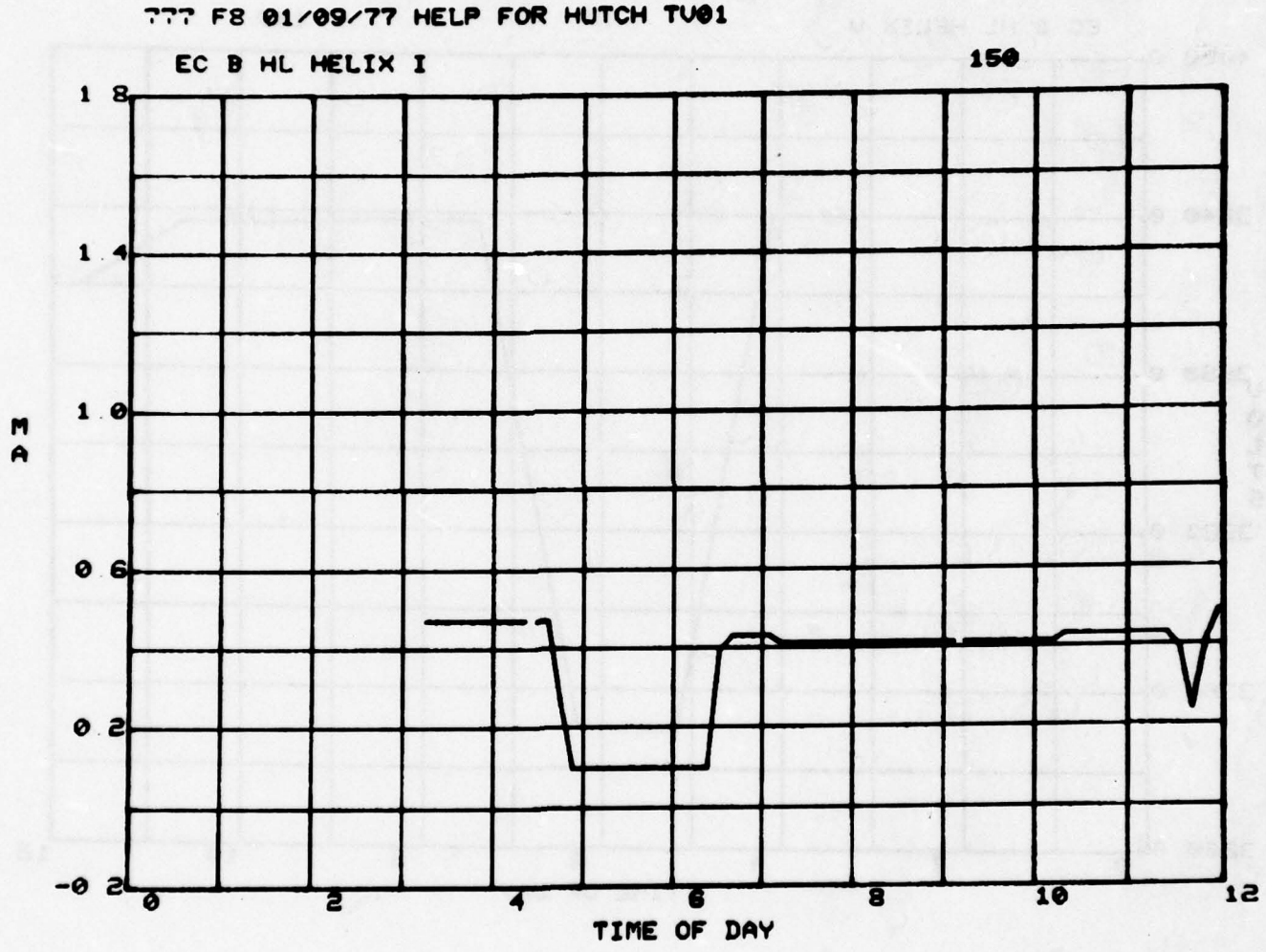
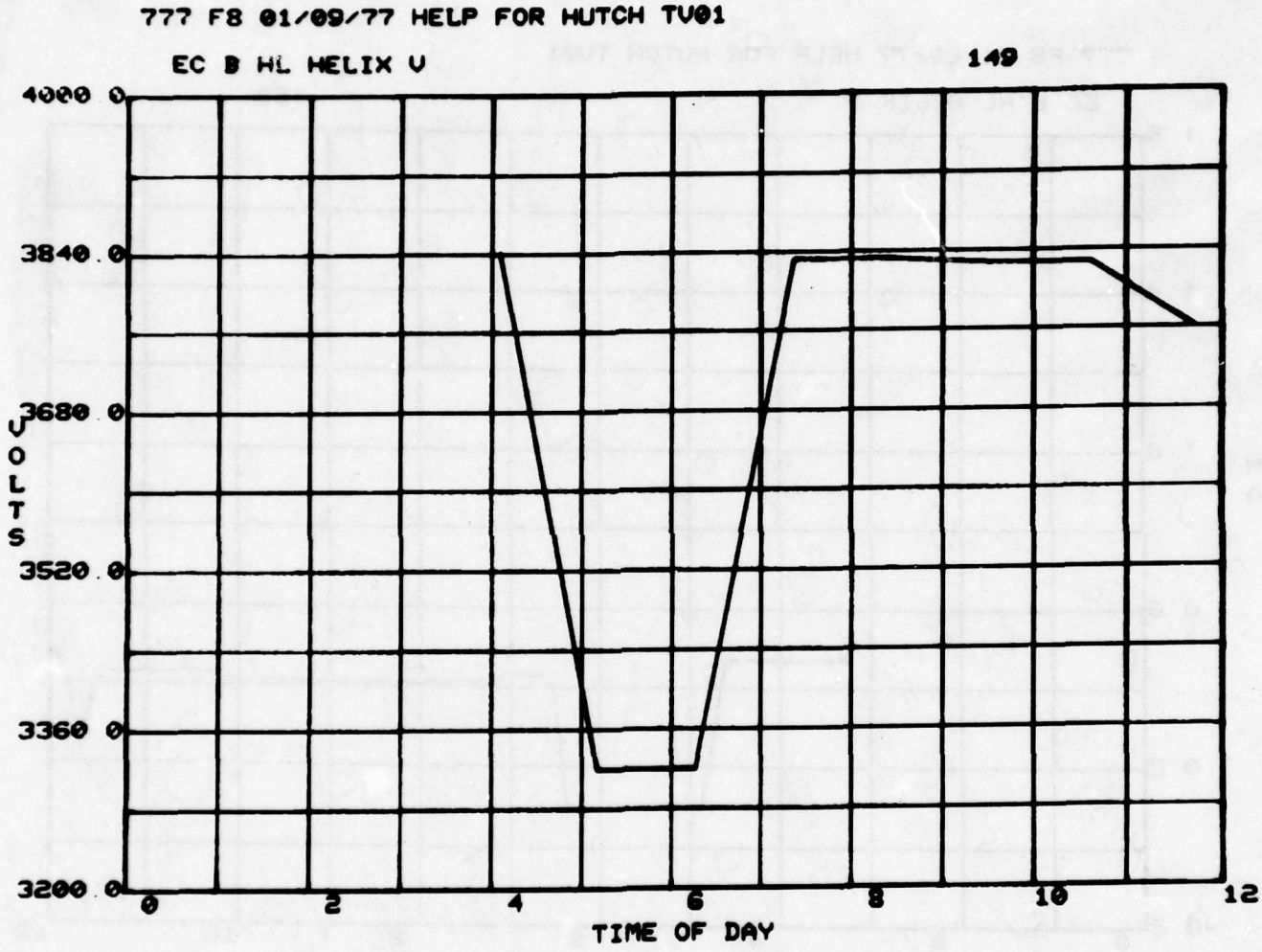
3200.0
VOLTS
2031
2033
2035
2037
2039
2041
2043
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
MAIN BUS VOLTS FLT8
100
35 0
34.0
33.0
32.0
31 0
30 0
VOLTS
2031
2033
2035
2037
2039
2041
2043
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH TV01
EC B HL INPUT I
148
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
2
3
4
5
6
7
8
TIME OF DAY


??? F8 01/09/77 HELP FOR HUTCH TV01
EC B HL HELIX I
150
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
0
2
4
6
8
10
12
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH TV01
EC B HL HELIX V
149
4000.0
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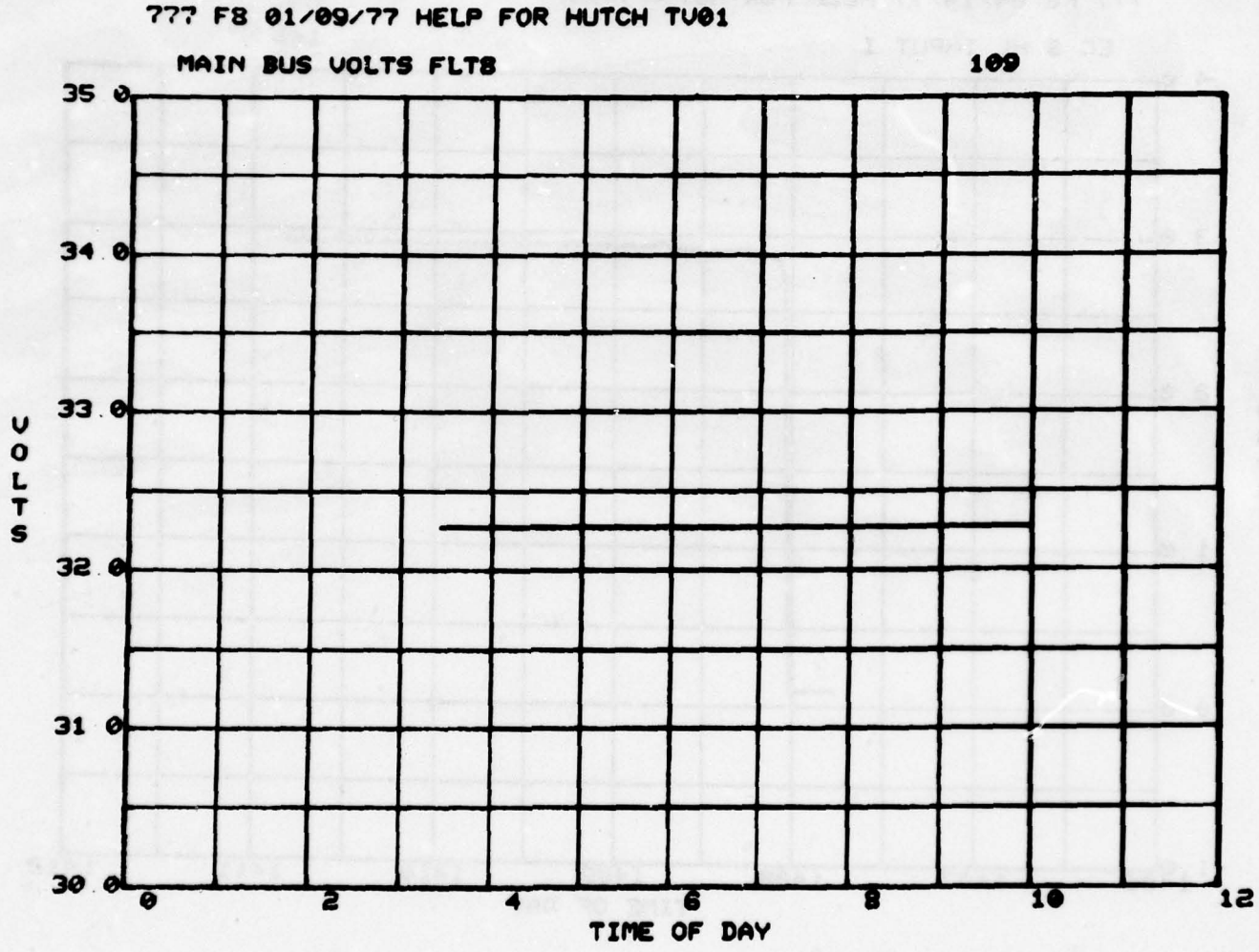
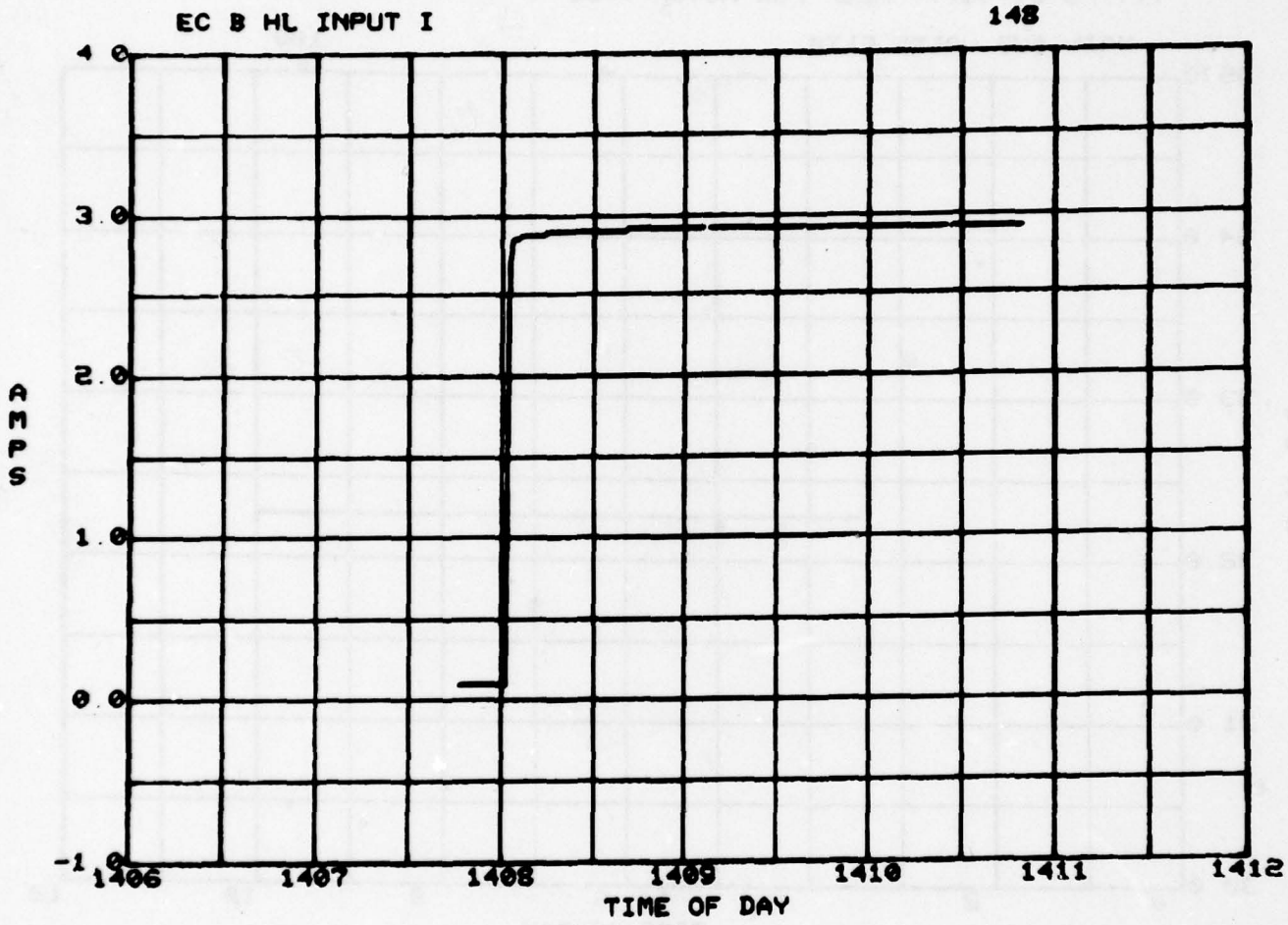
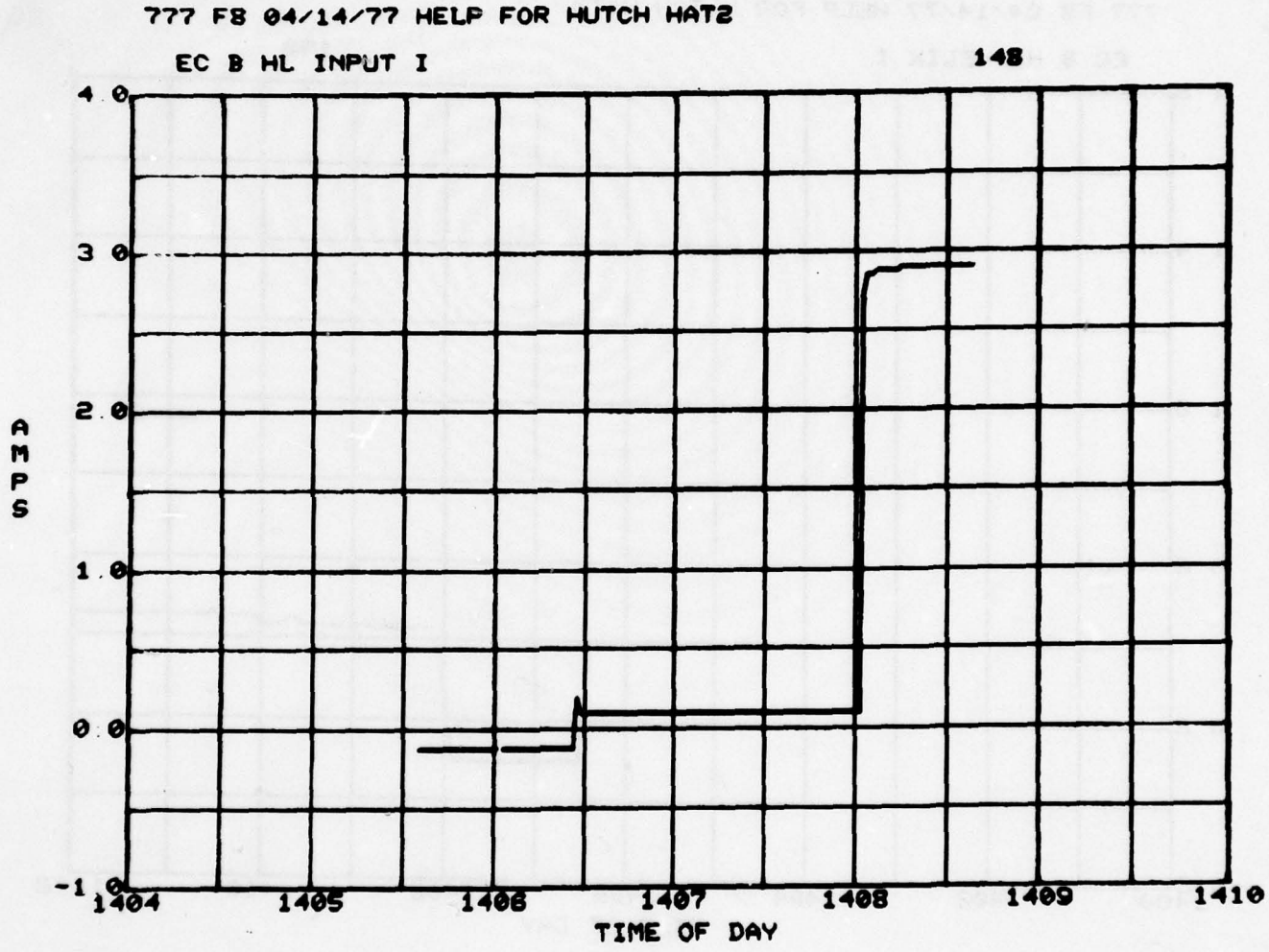
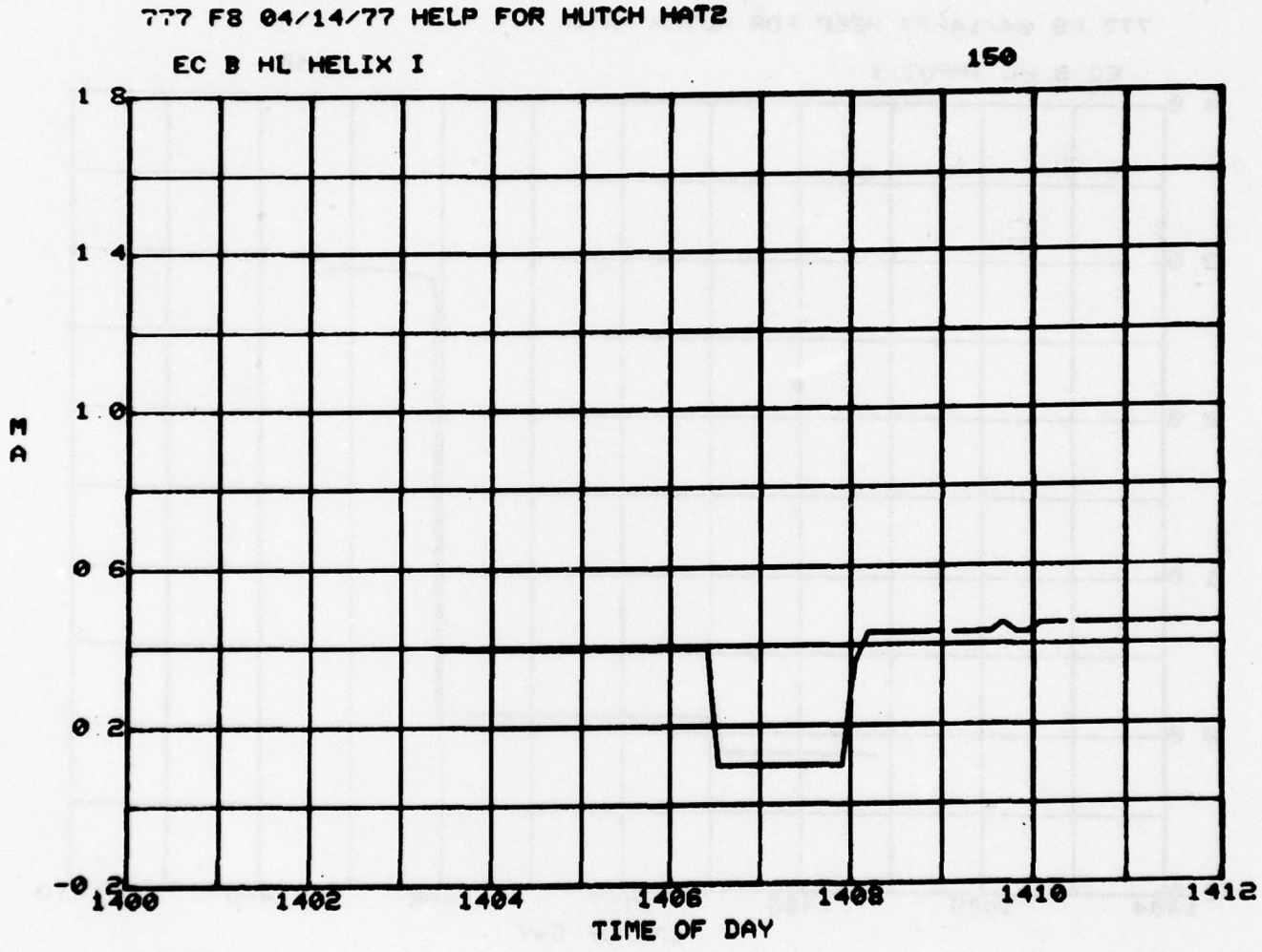
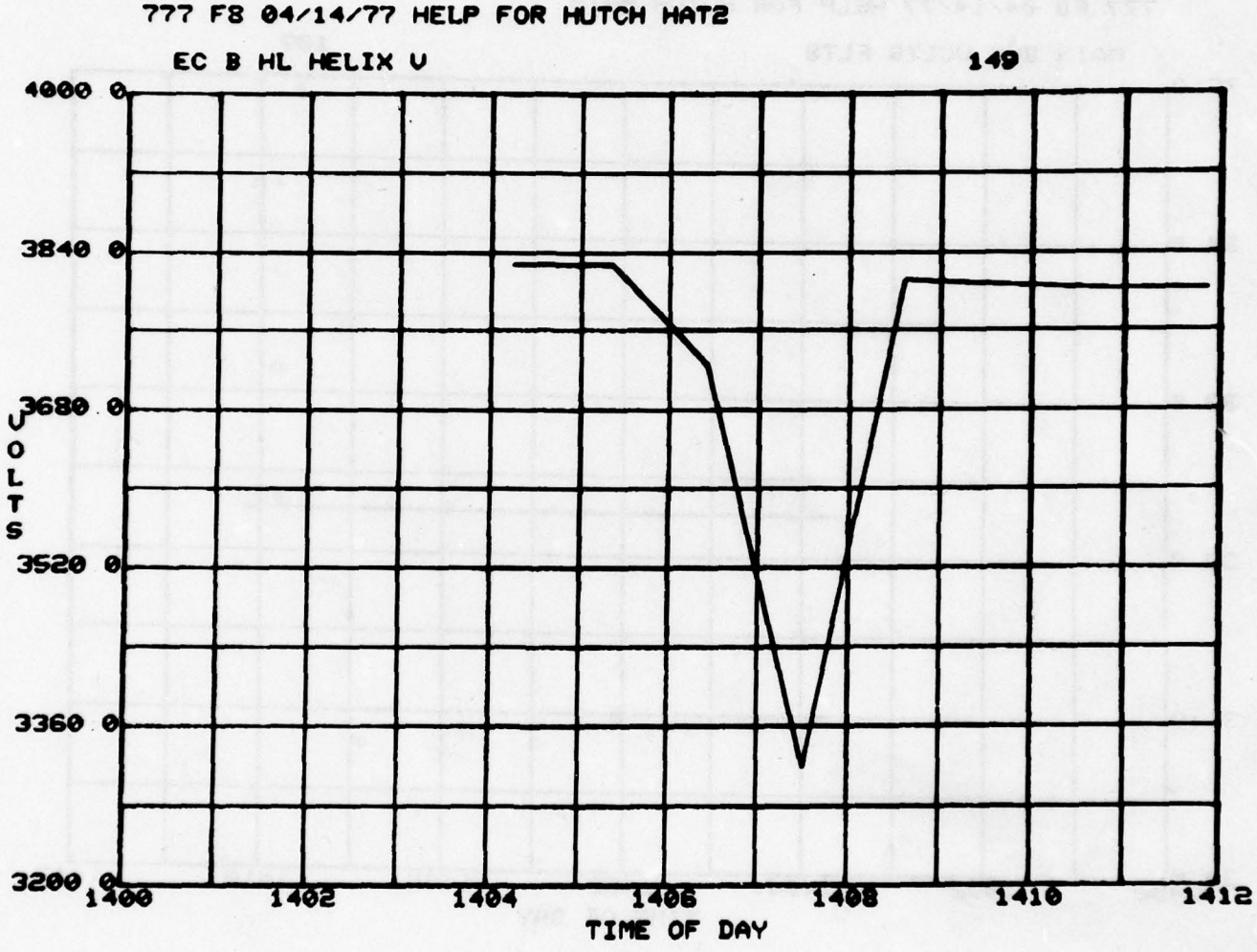
3520.0
3360.0
3200.0
VOLTS
0
2
4
6
8
10
12
TIME OF DAY

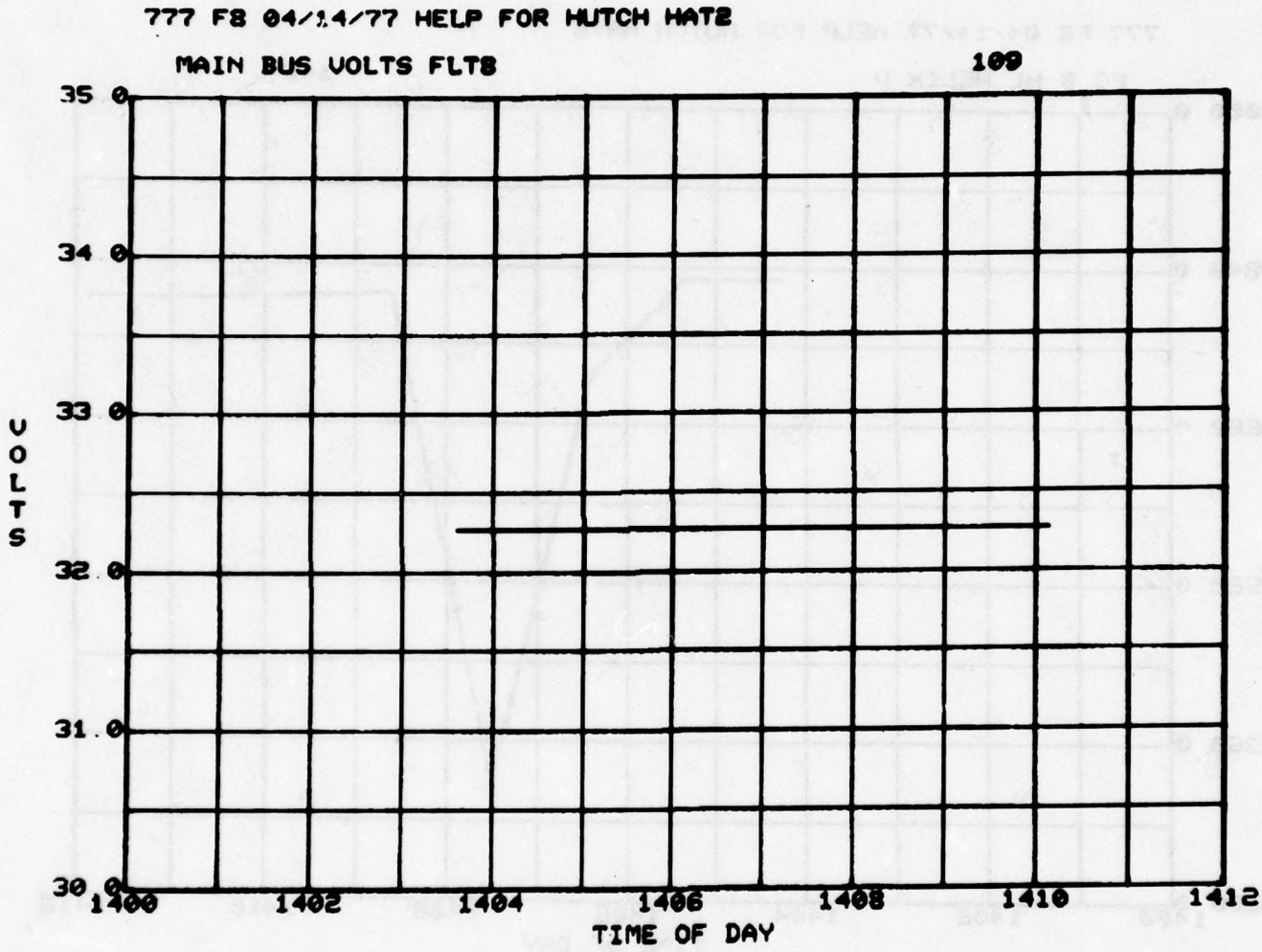

777 F8 01/09/77 HELP FOR HUTCH TV01
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
0
2
4
6
8
10
12
TIME OF DAY

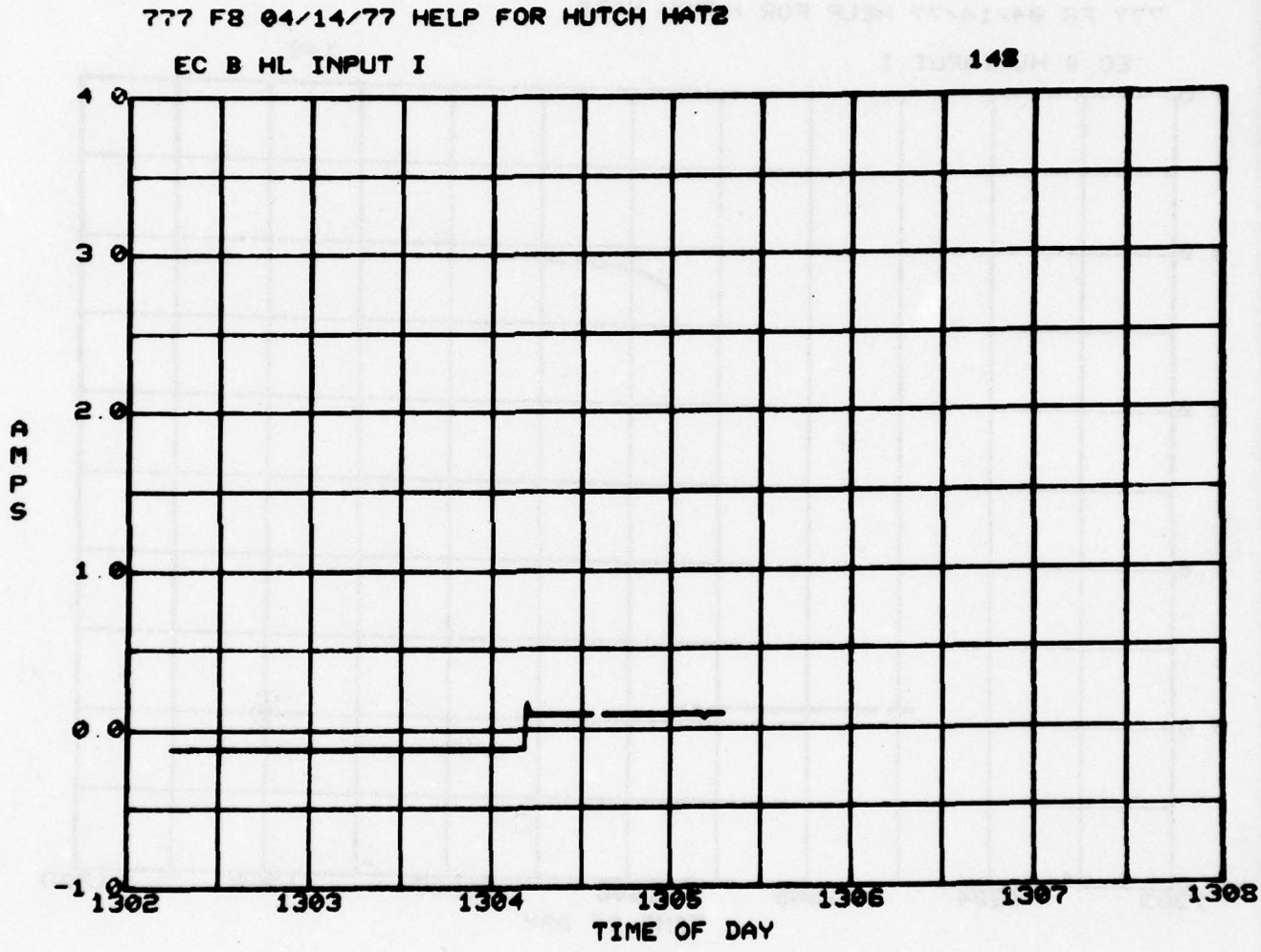

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1406
1407
1408
1409
1410
1411
1412
TIME OF DAY

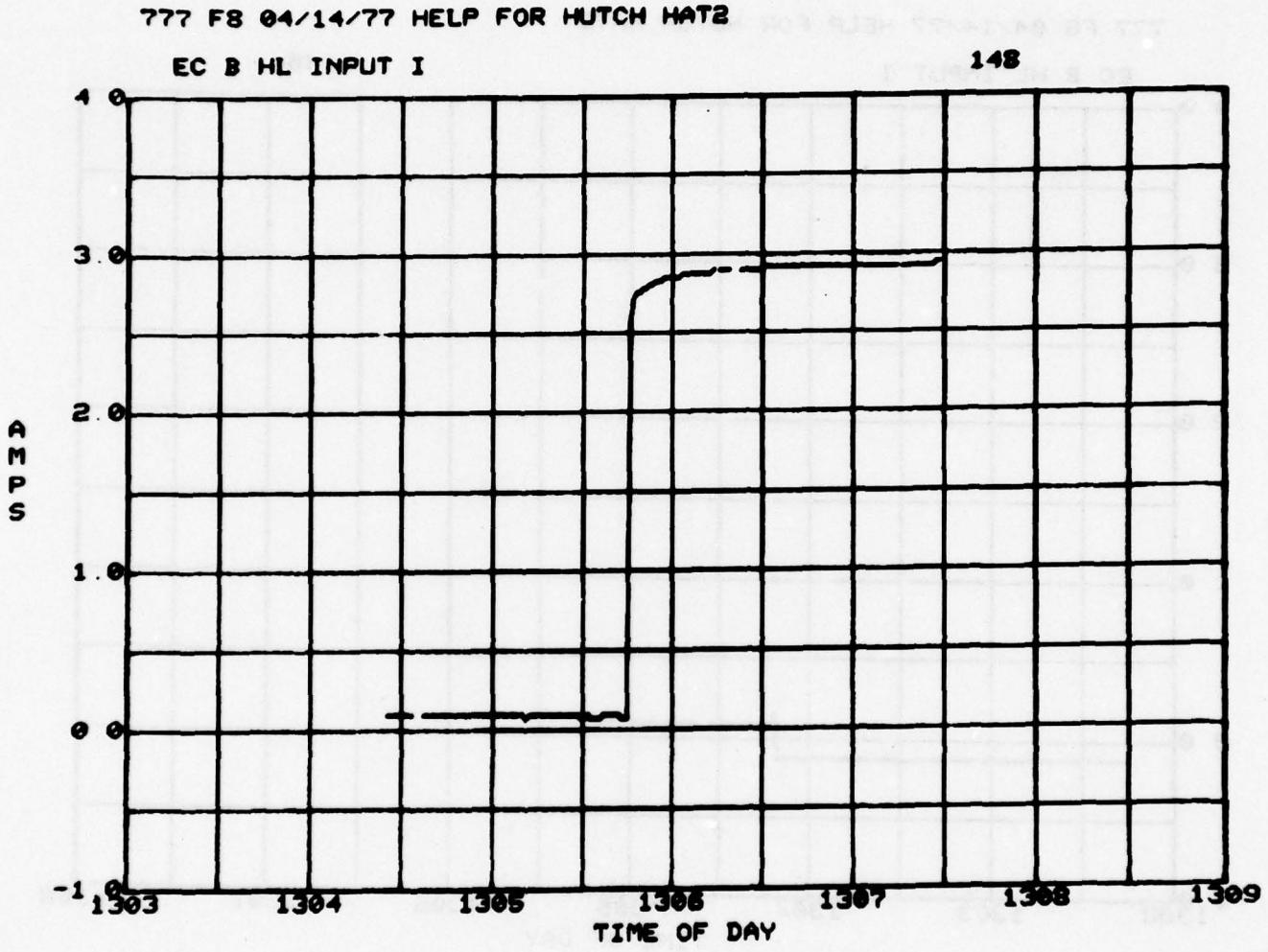

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1404
1405
1406
1407
1408
1409
1410
TIME OF DAY

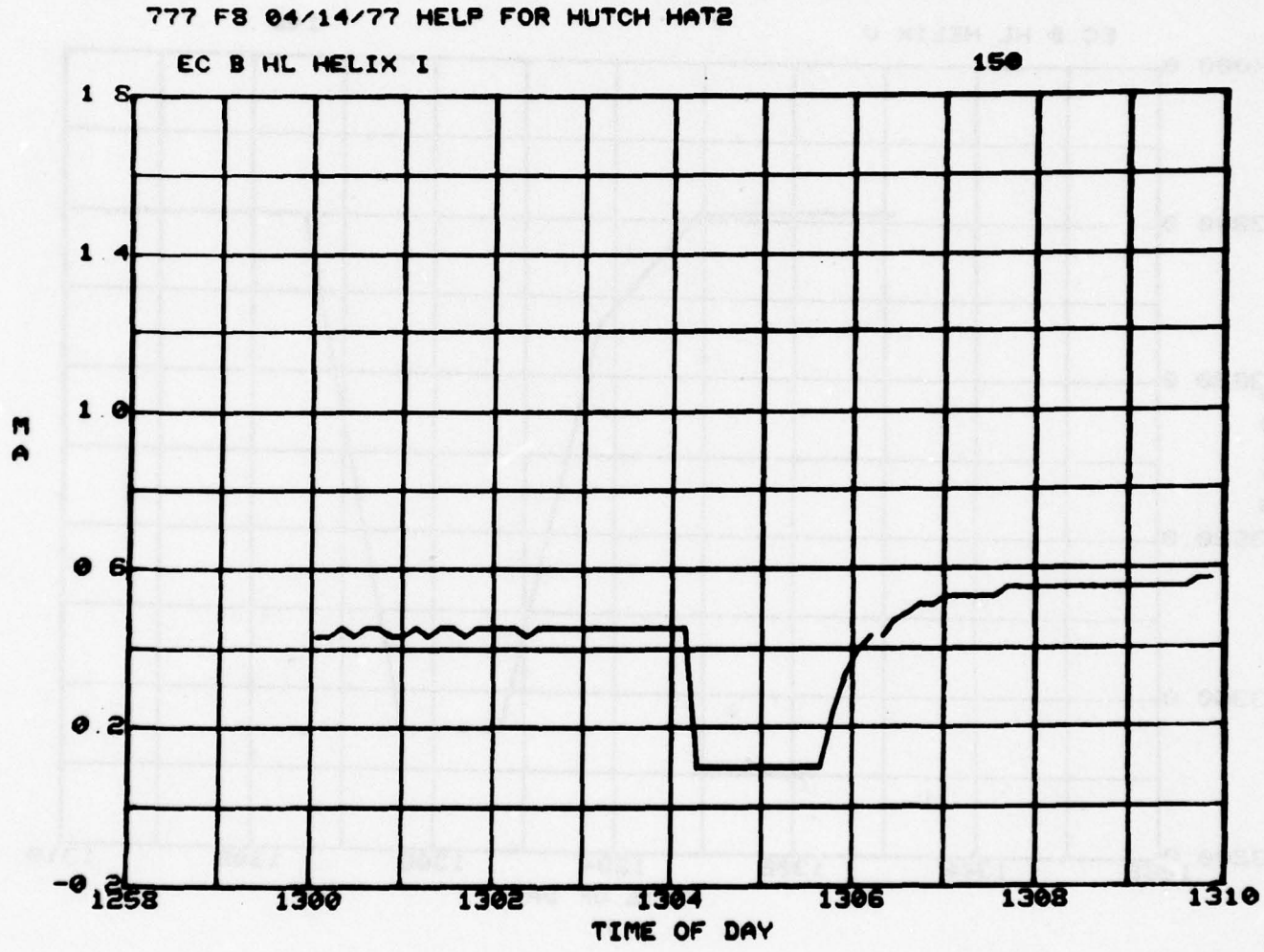

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC B HL HELIX I
150
1 8
1 4
1 0
0 6
0 2
-0 2
MA
1400
1402
1404
1406
1408
1410
1412
TIME OF DAY

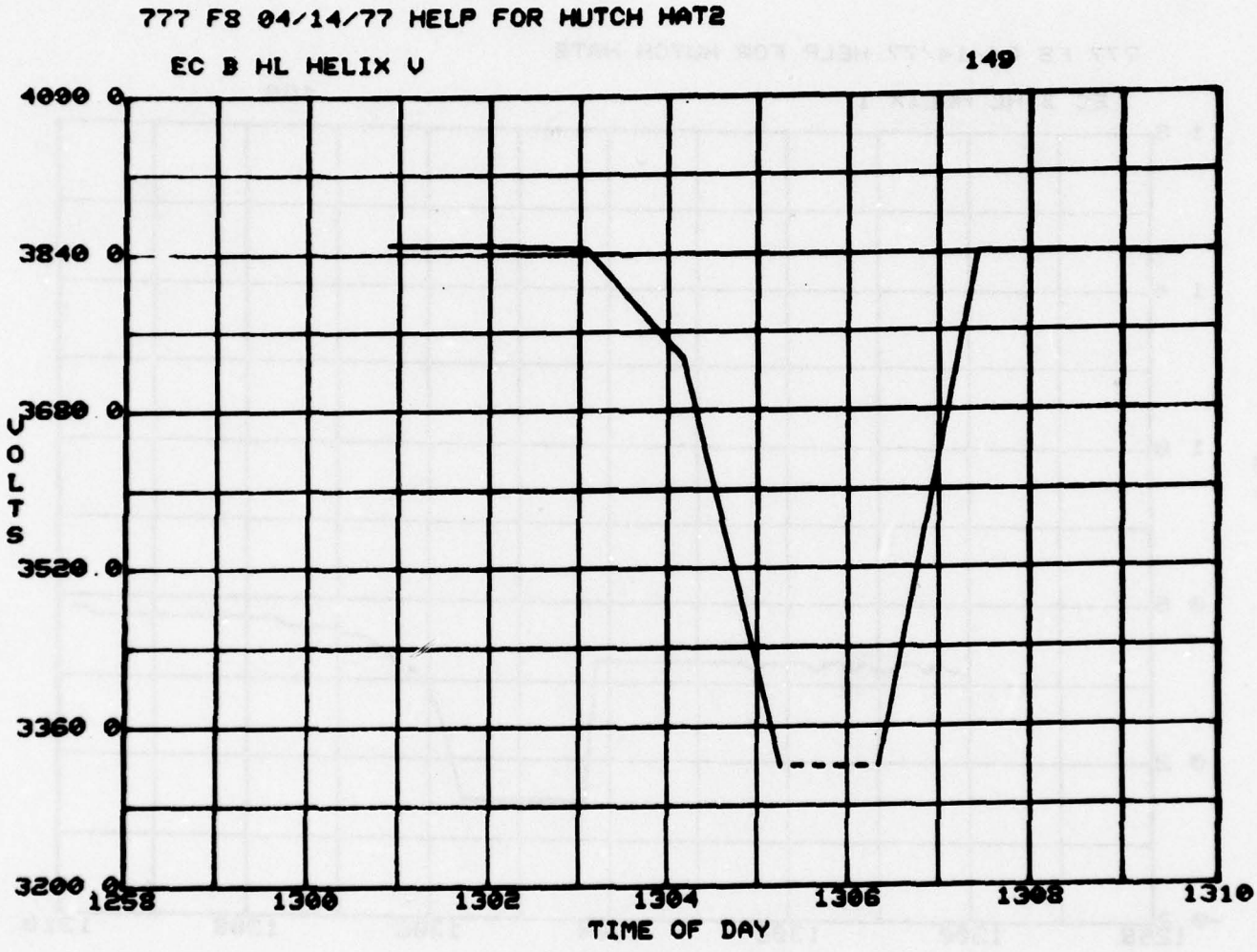

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC B HL HELIX V
149
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
1400
1402
1404
1406
1408
1410
1412
TIME OF DAY

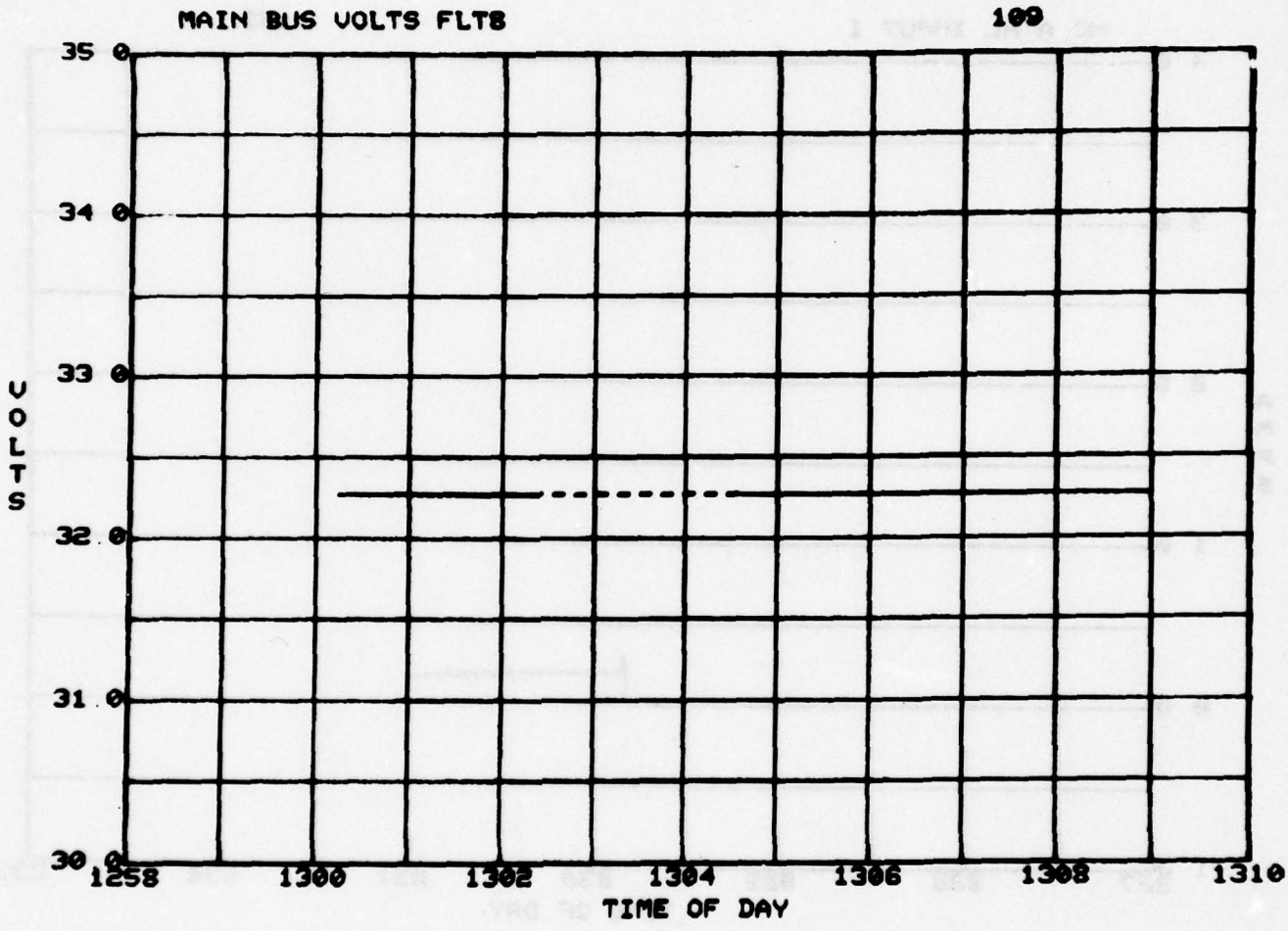

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1400
1402
1404
1406
1408
1410
1412
TIME OF DAY

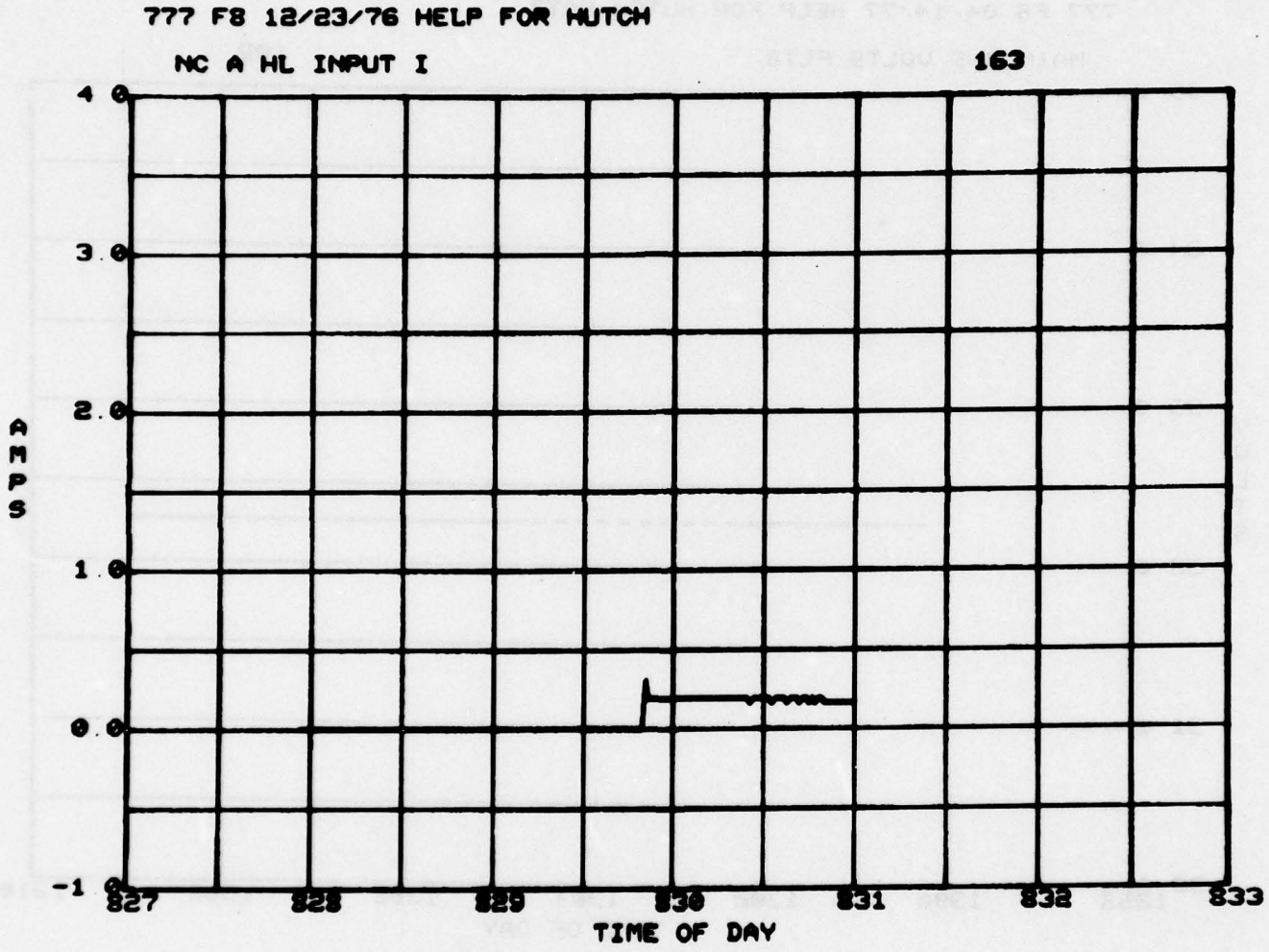

777 F8 04/14/77 HELP FOR HUTCH HAT2
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1302
1303
1304
1305
1306
1307
1308
TIME OF DAY

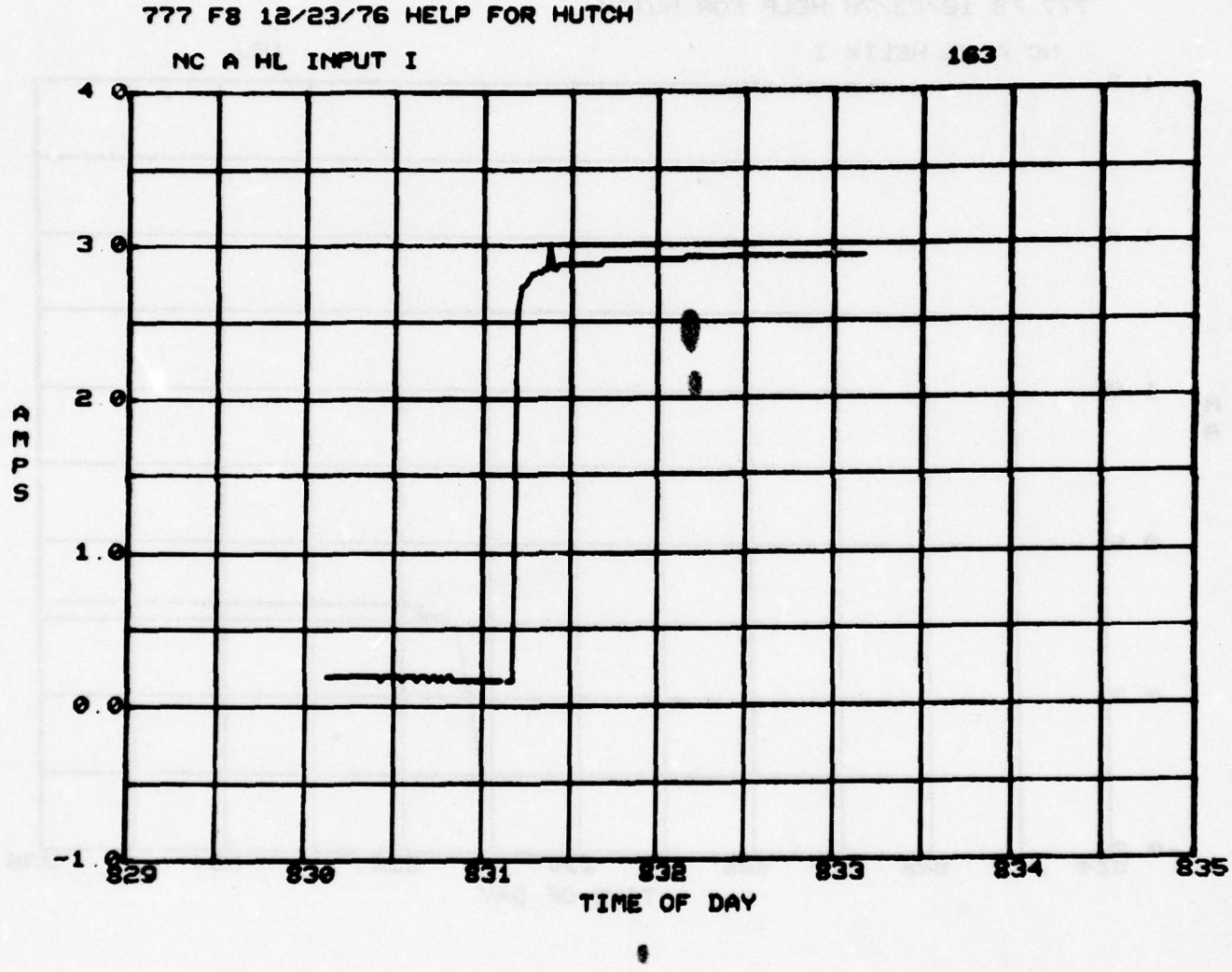

777 FS 04/14/77 HELP FOR HUTCH HAT2
EC B HL INPUT I
148
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1303
1304
1305
1306
1307
1308
1309
TIME OF DAY

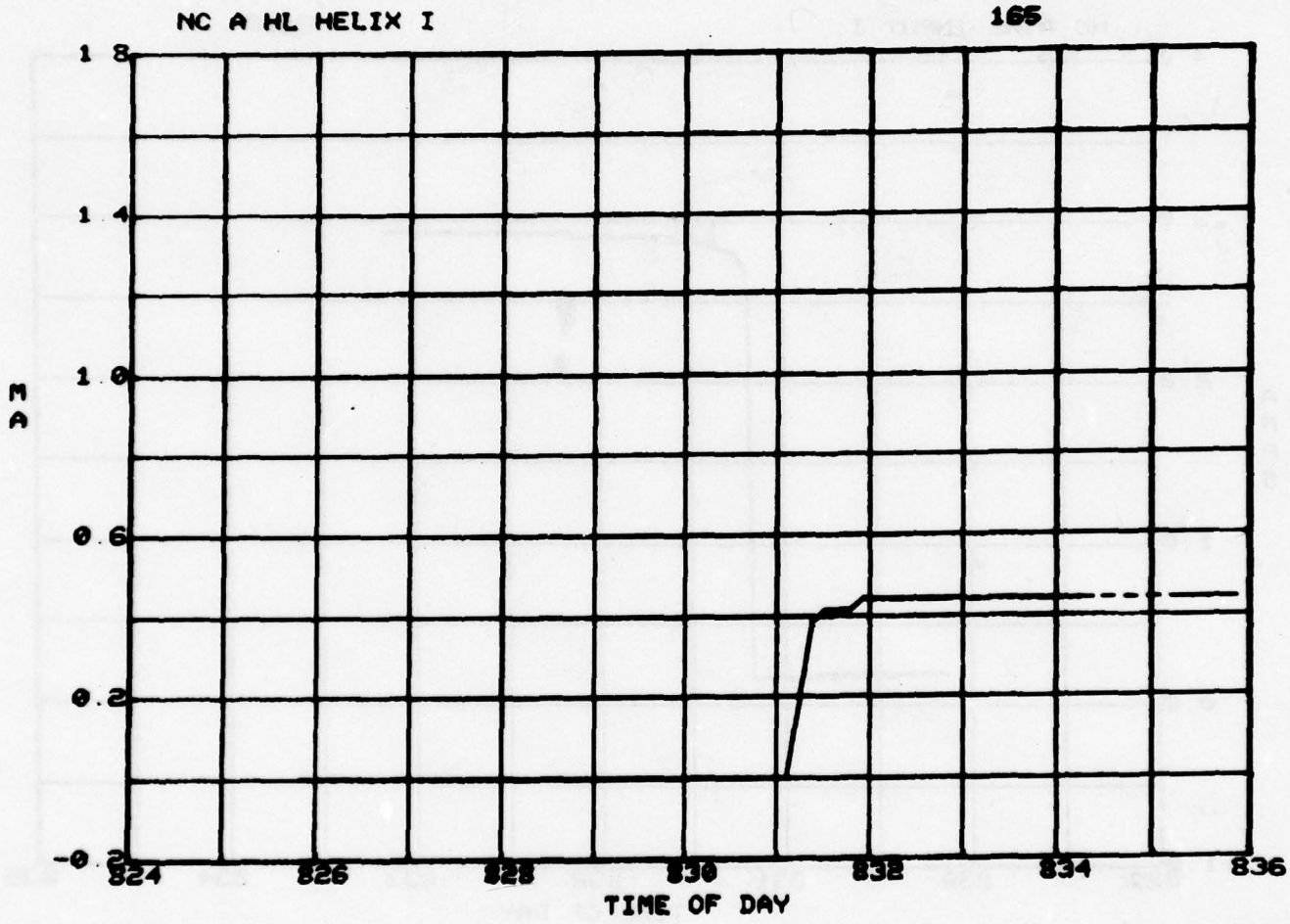

777 FS 04/14/77 HELP FOR HUTCH HAT2
EC B HL HELIX I
150
1 8
1 4
1 0
0 6
0 2
-0 2
MA
1258
1300
1302
1304
1306
1308
1310
TIME OF DAY

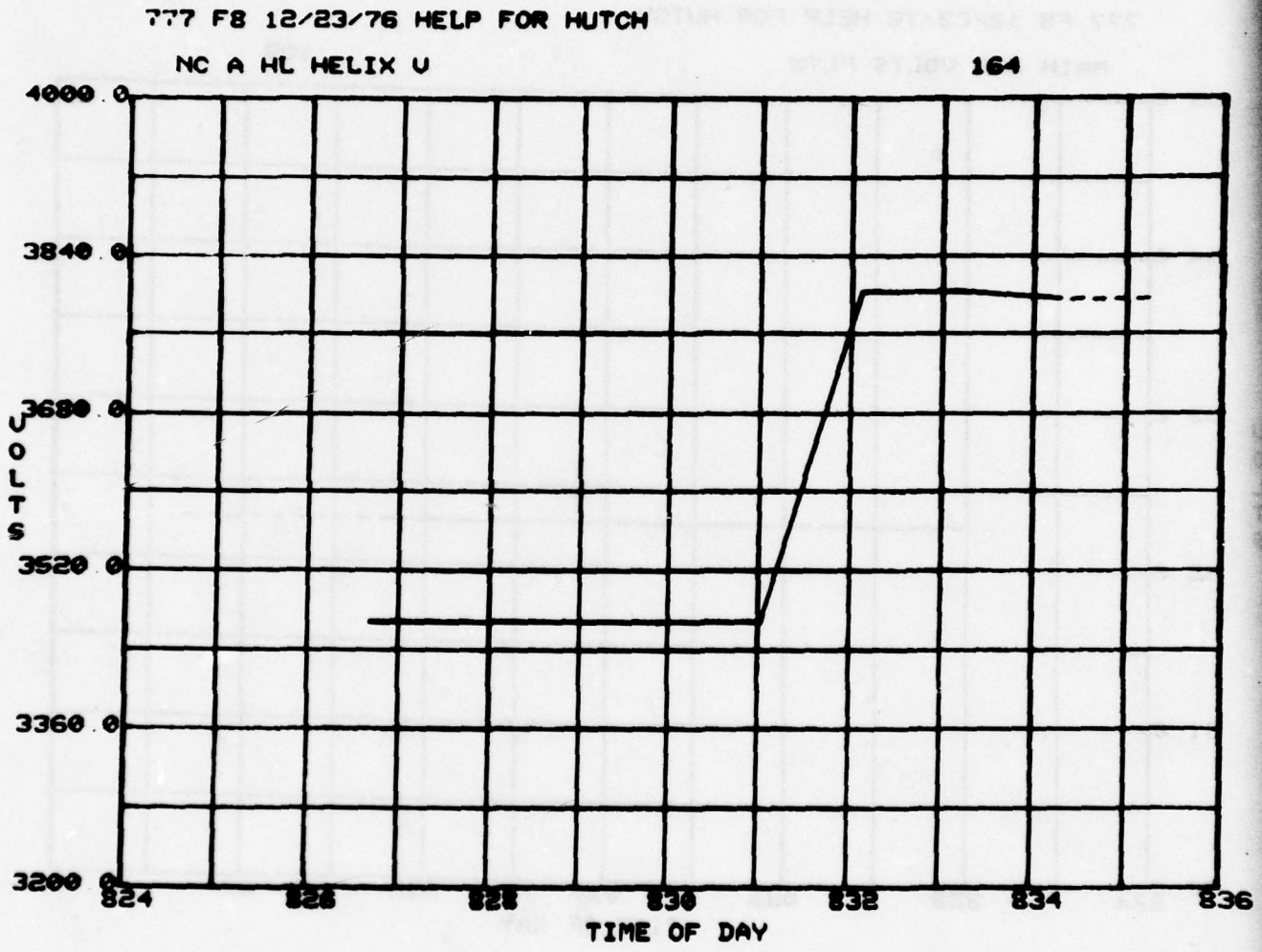

777 FS 04/14/77 HELP FOR HUTCH HAT2
EC B HL HELIX V
149
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
1258
1300
1302
1304
1306
1308
1310
TIME OF DAY

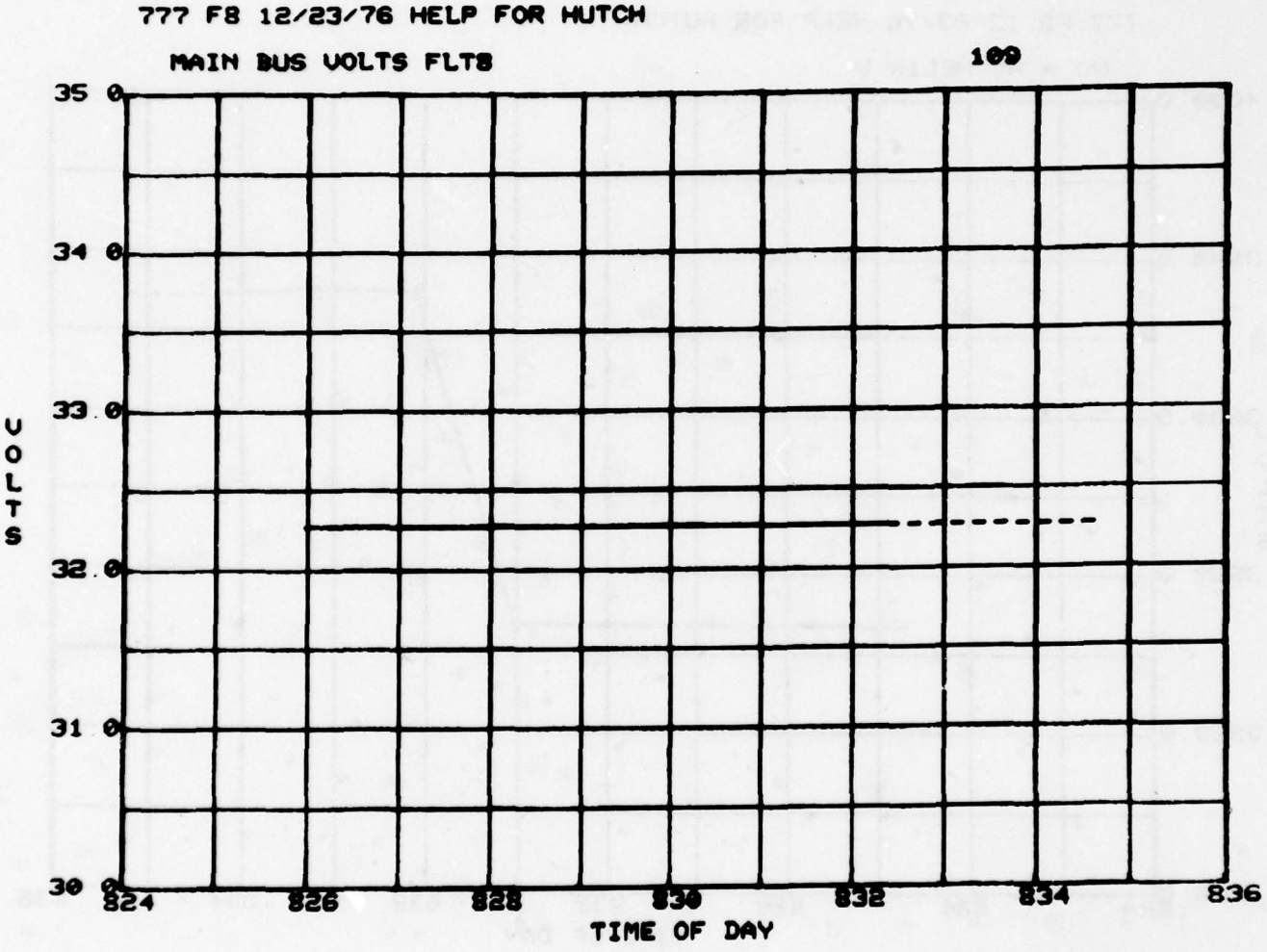

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
100
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
1258
1300
1302
1304
1306
1308
1310
TIME OF DAY

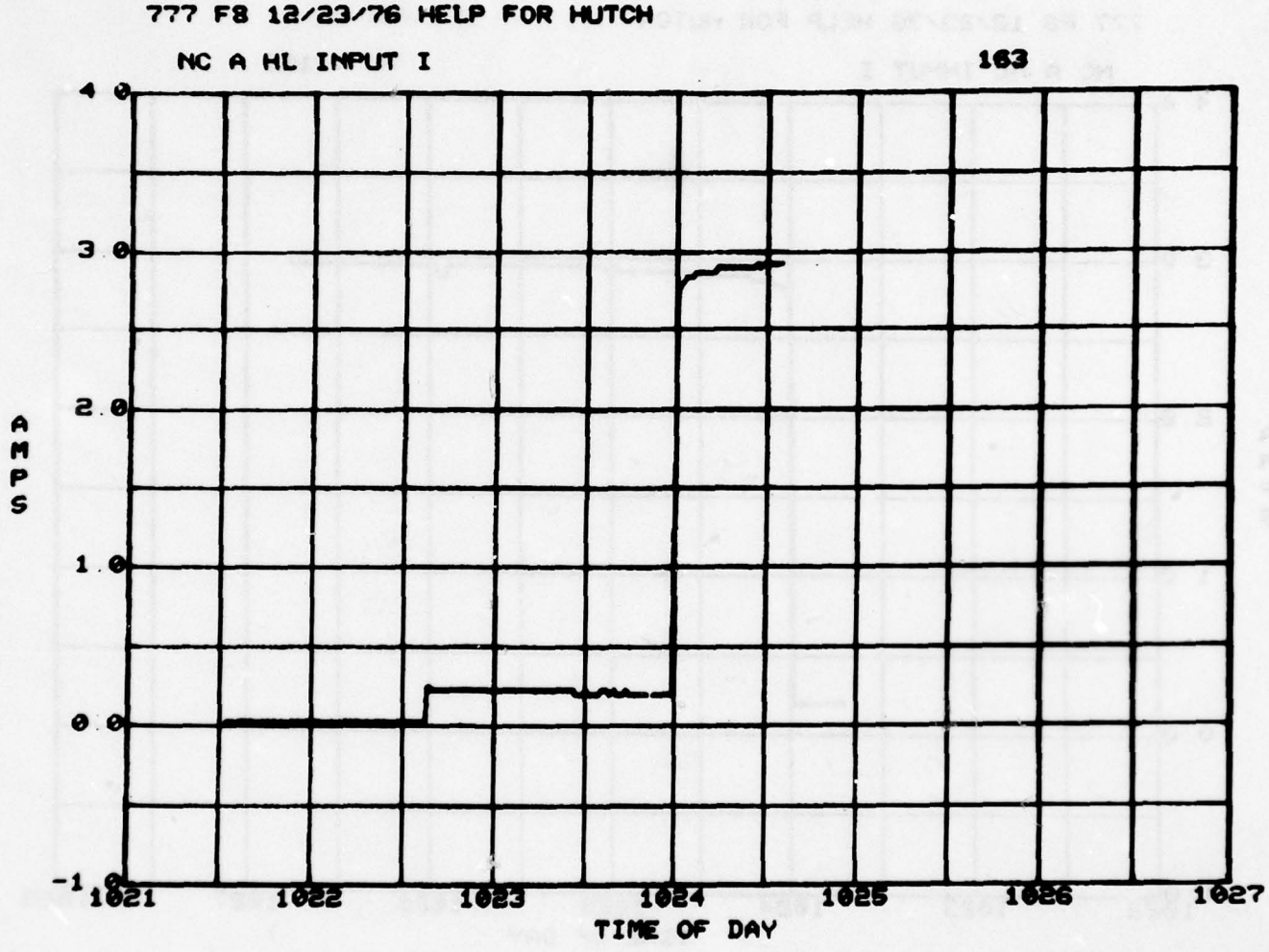

777 F8 12/23/76 HELP FOR HUTCH
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
827
828
829
830
831
832
833
TIME OF DAY

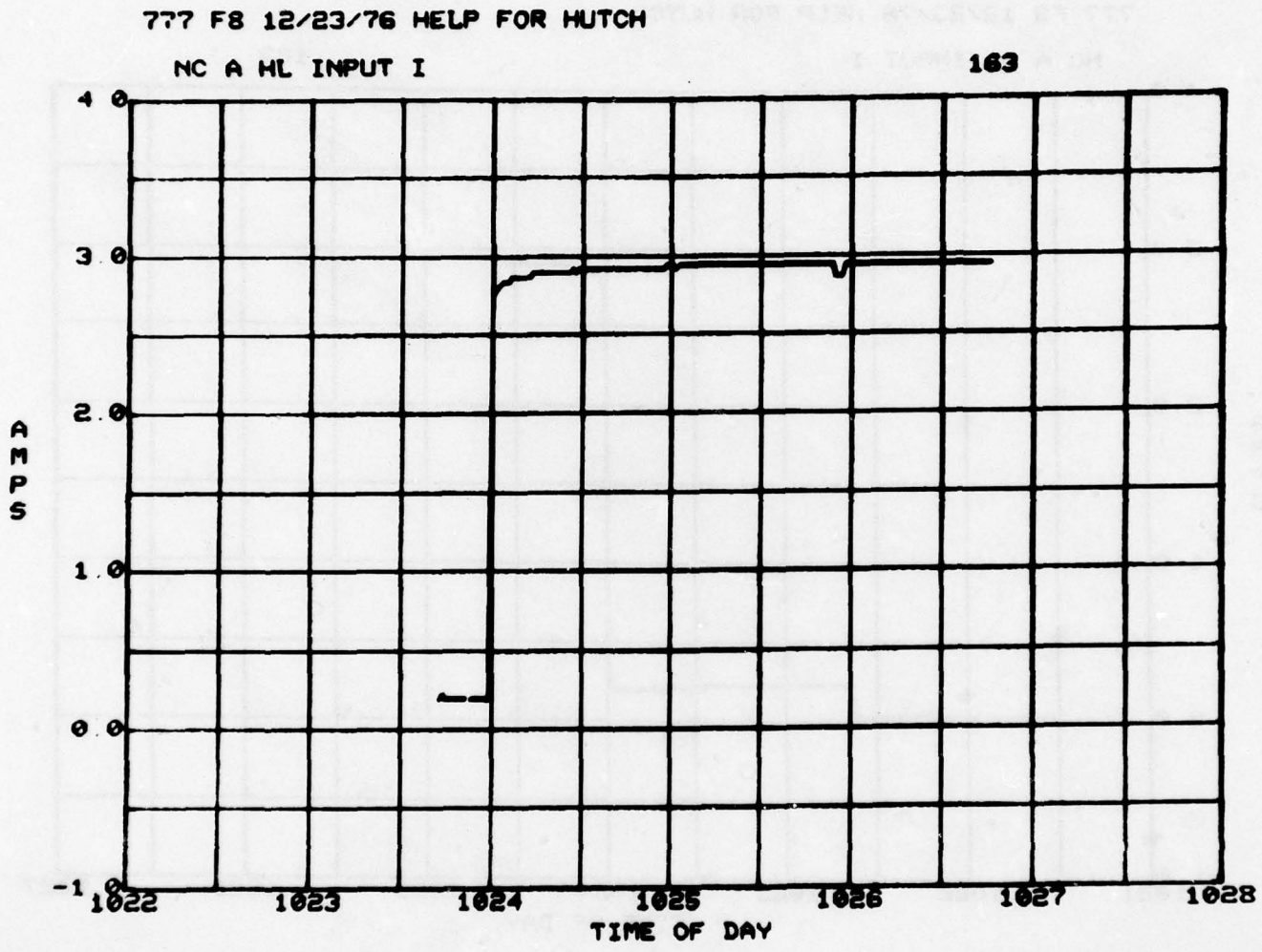

777 F8 12/23/76 HELP FOR HUTCH
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
829
830
831
832
833
834
835
TIME OF DAY

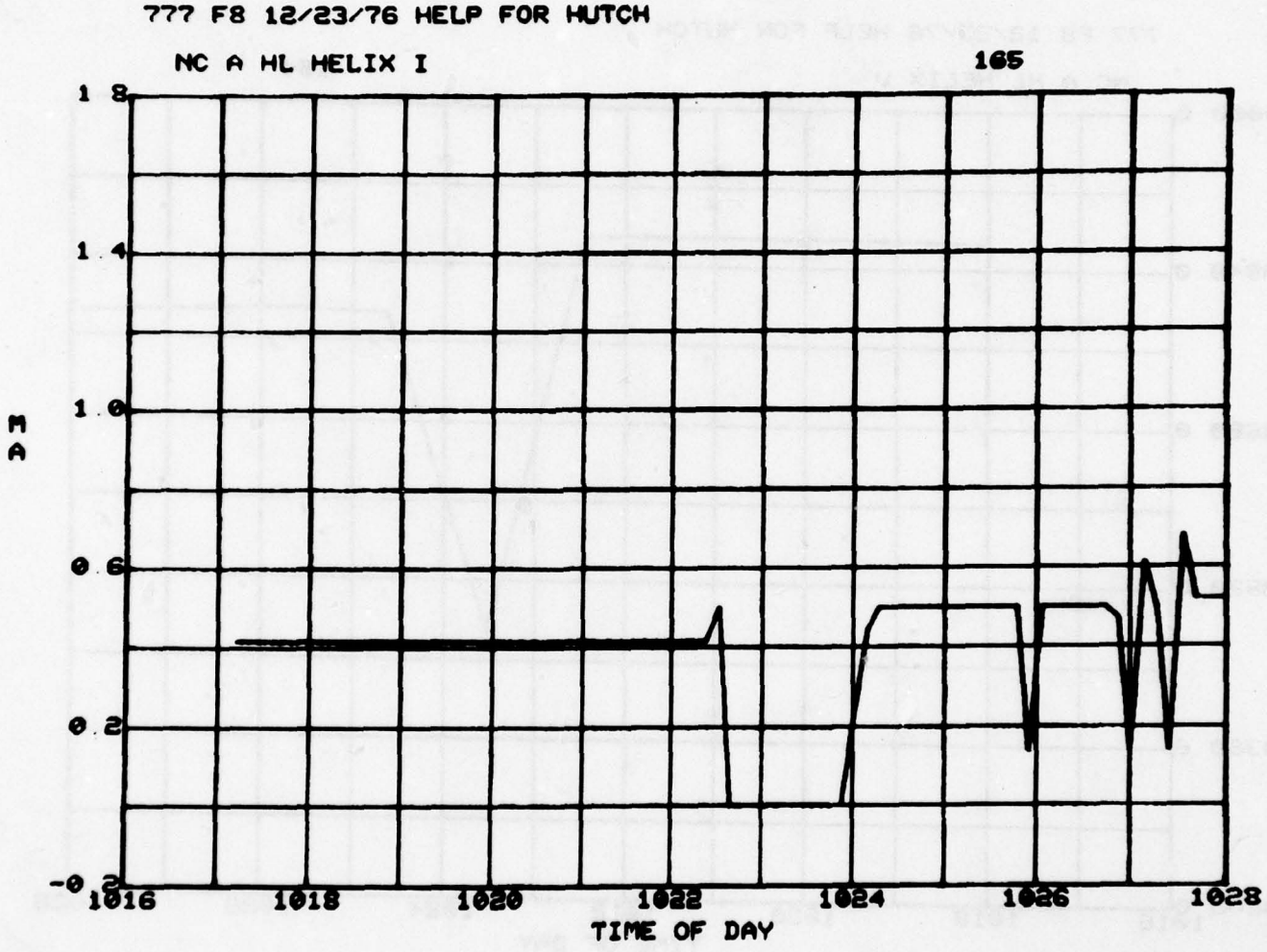

777 F8 12/23/76 HELP FOR HUTCH
NC A HL HELIX I
165
1.8
1.4
1.0
0.6
0.2
-0.2
MA
824
826
828
830
832
834
836
TIME OF DAY

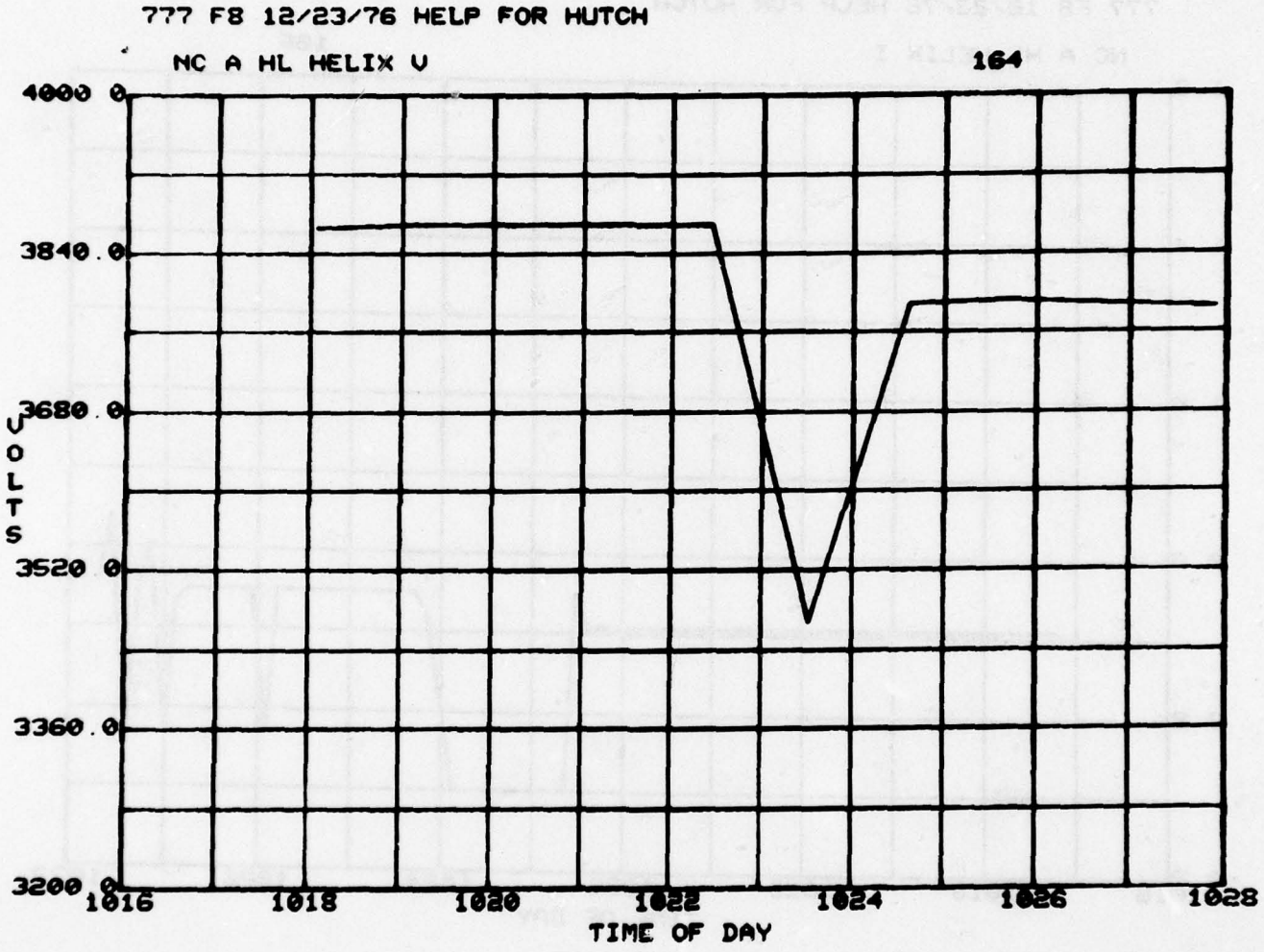

777 F8 12/23/76 HELP FOR HUTCH
NC A HL HELIX U
164
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
824
826
828
830
832
834
836
TIME OF DAY

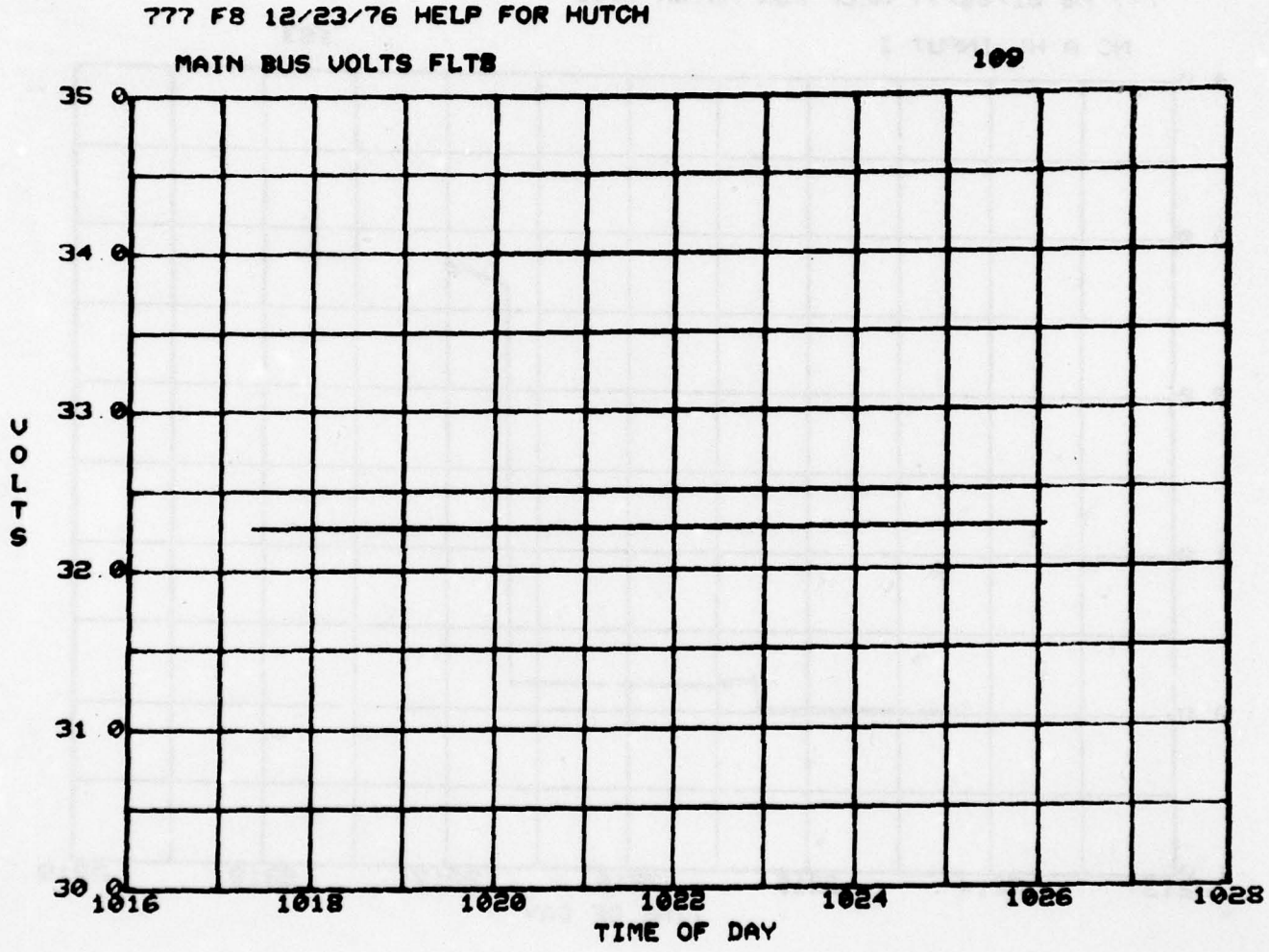

777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
109
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
824
826
828
830
832
834
836
TIME OF DAY

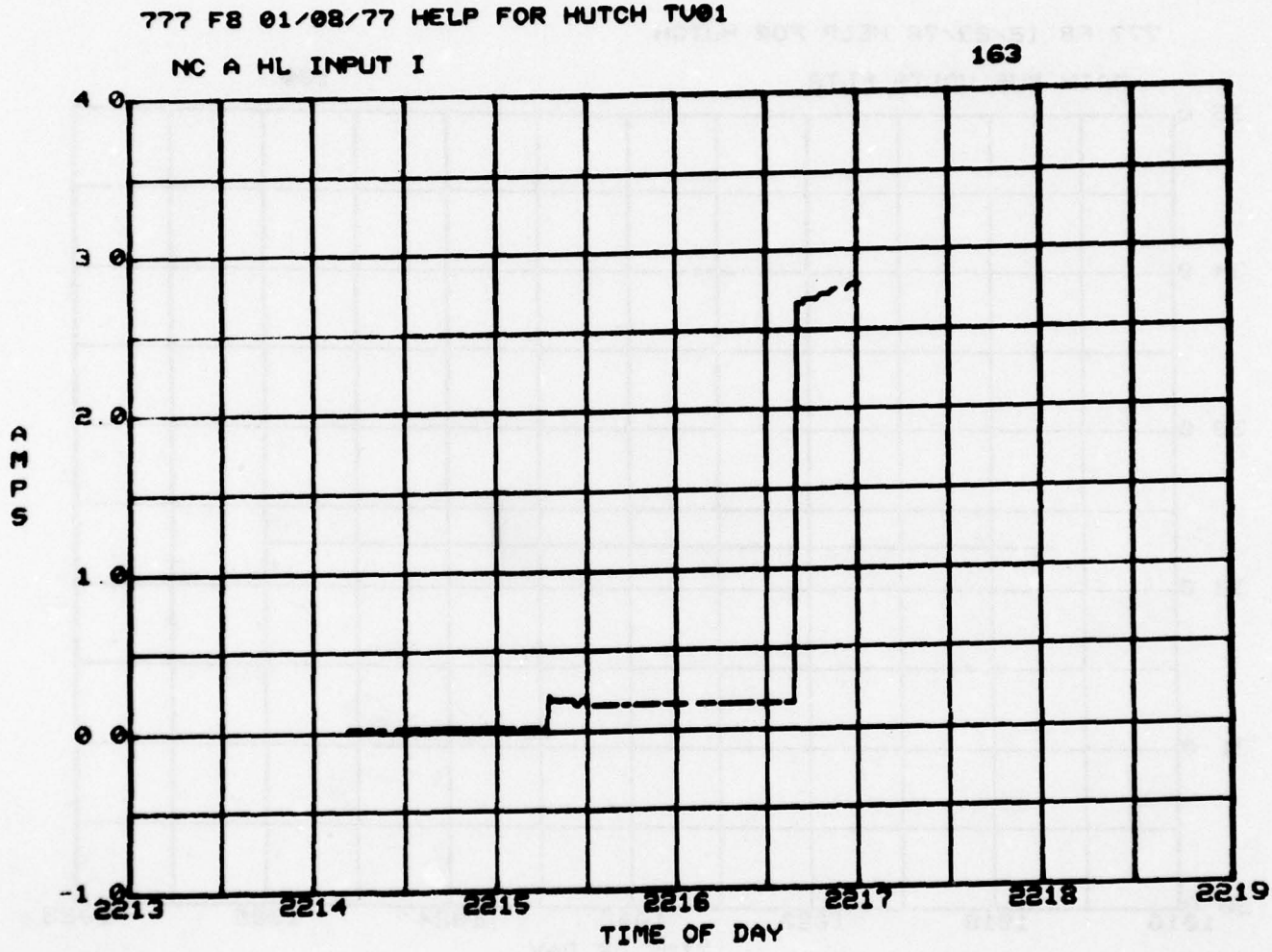

777 F8 12/23/76 HELP FOR HUTCH
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1021
1022
1023
1024
1025
1026
1027
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1022
1023
1024
1025
1026
1027
1028
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
NC A HL HELIX I
165
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1016
1018
1020
1022
1024
1026
1028
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
NC A HL HELIX V
164
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1016
1018
1020
1022
1024
1026
1028
TIME OF DAY


777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLTB
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1016
1018
1020
1022
1024
1026
1028
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
NC A HL INPUT I
163
4 0
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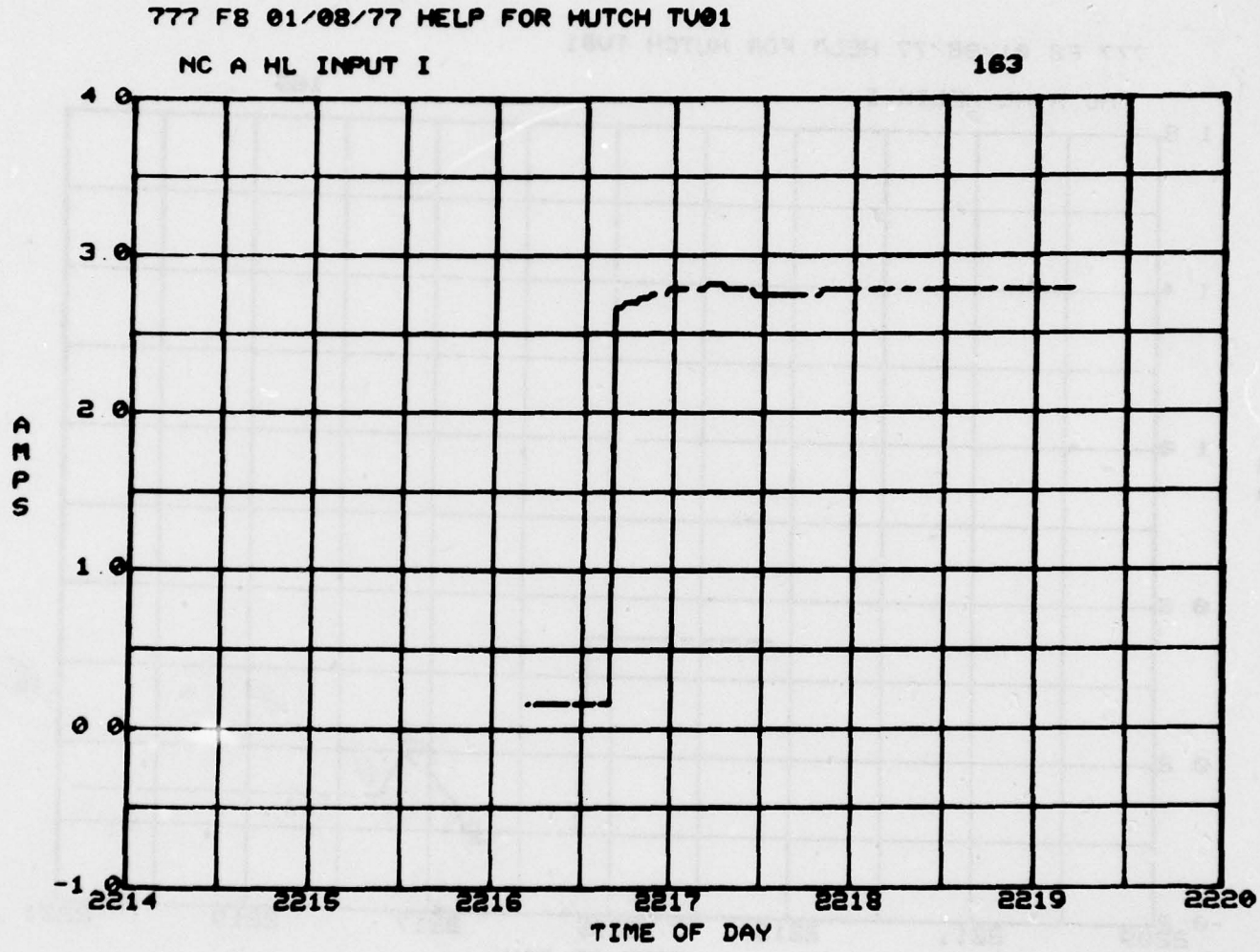
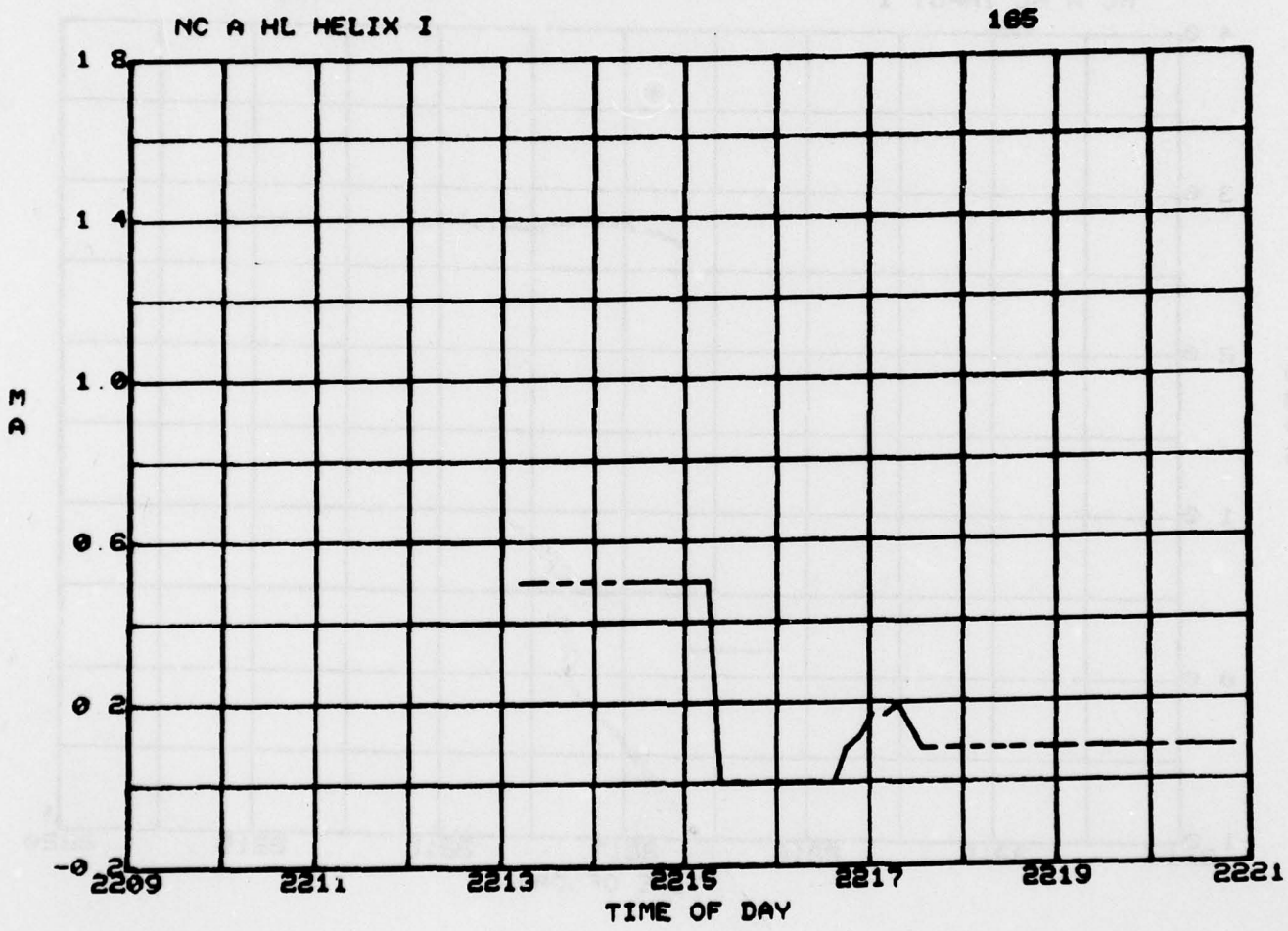
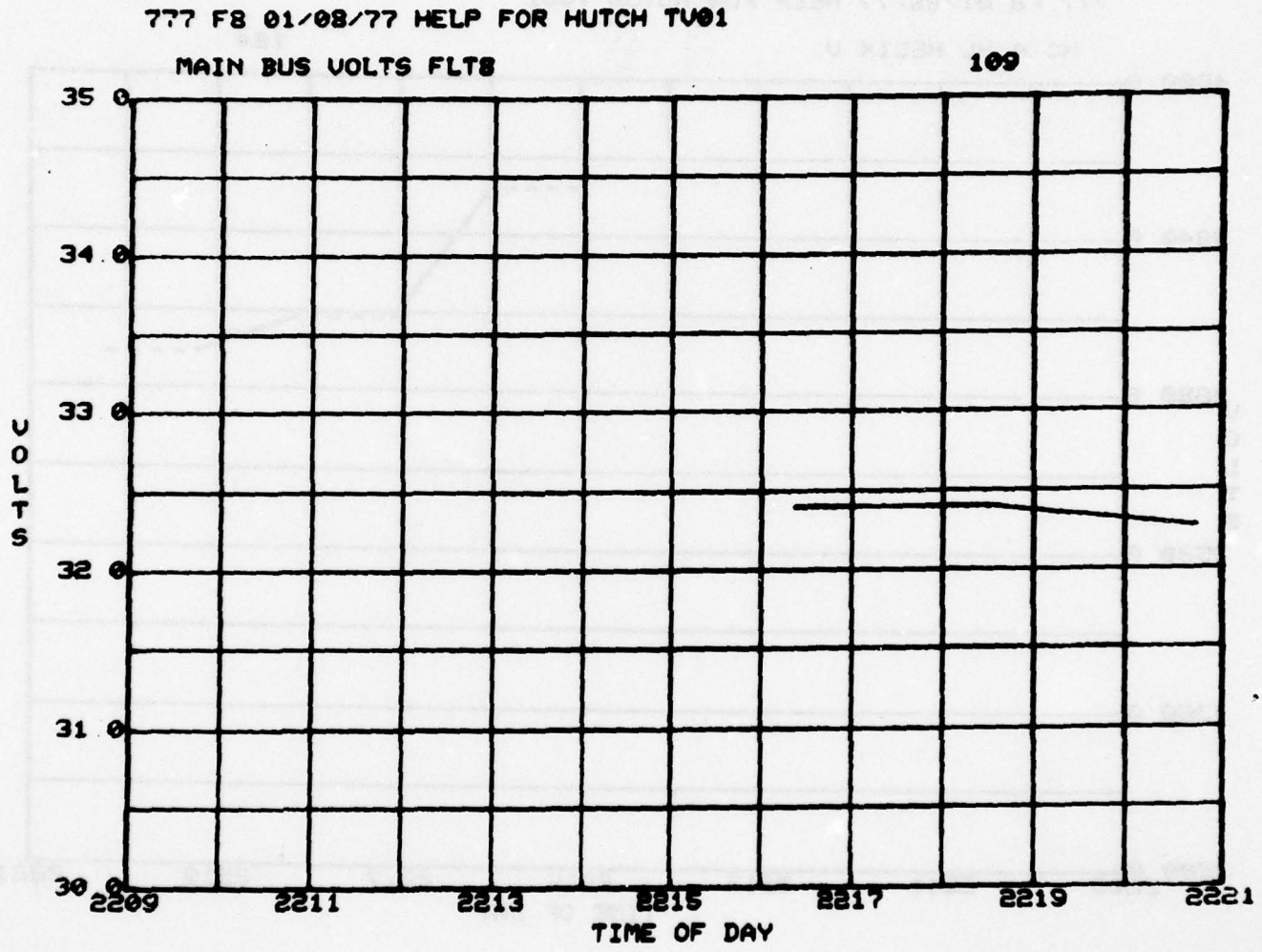
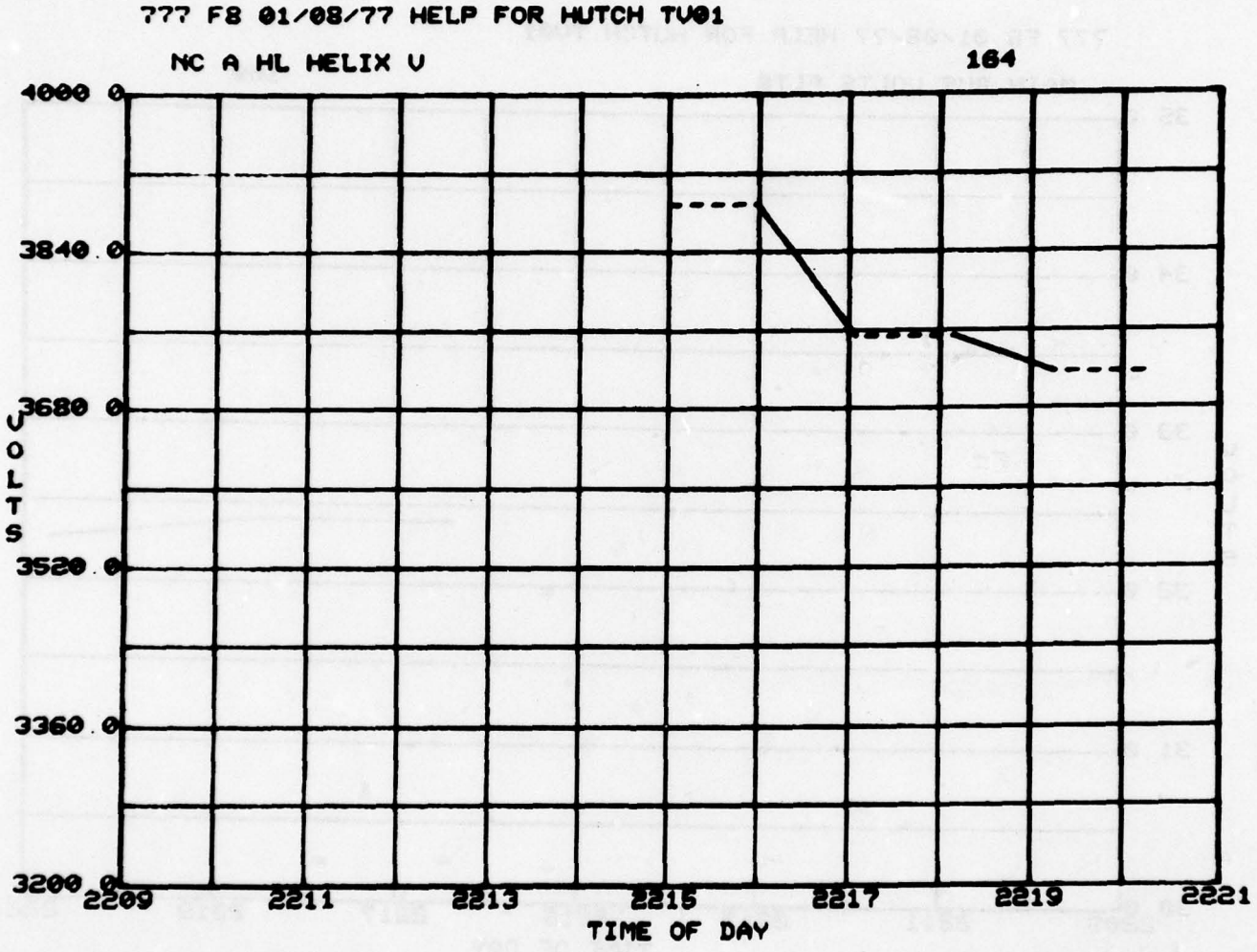
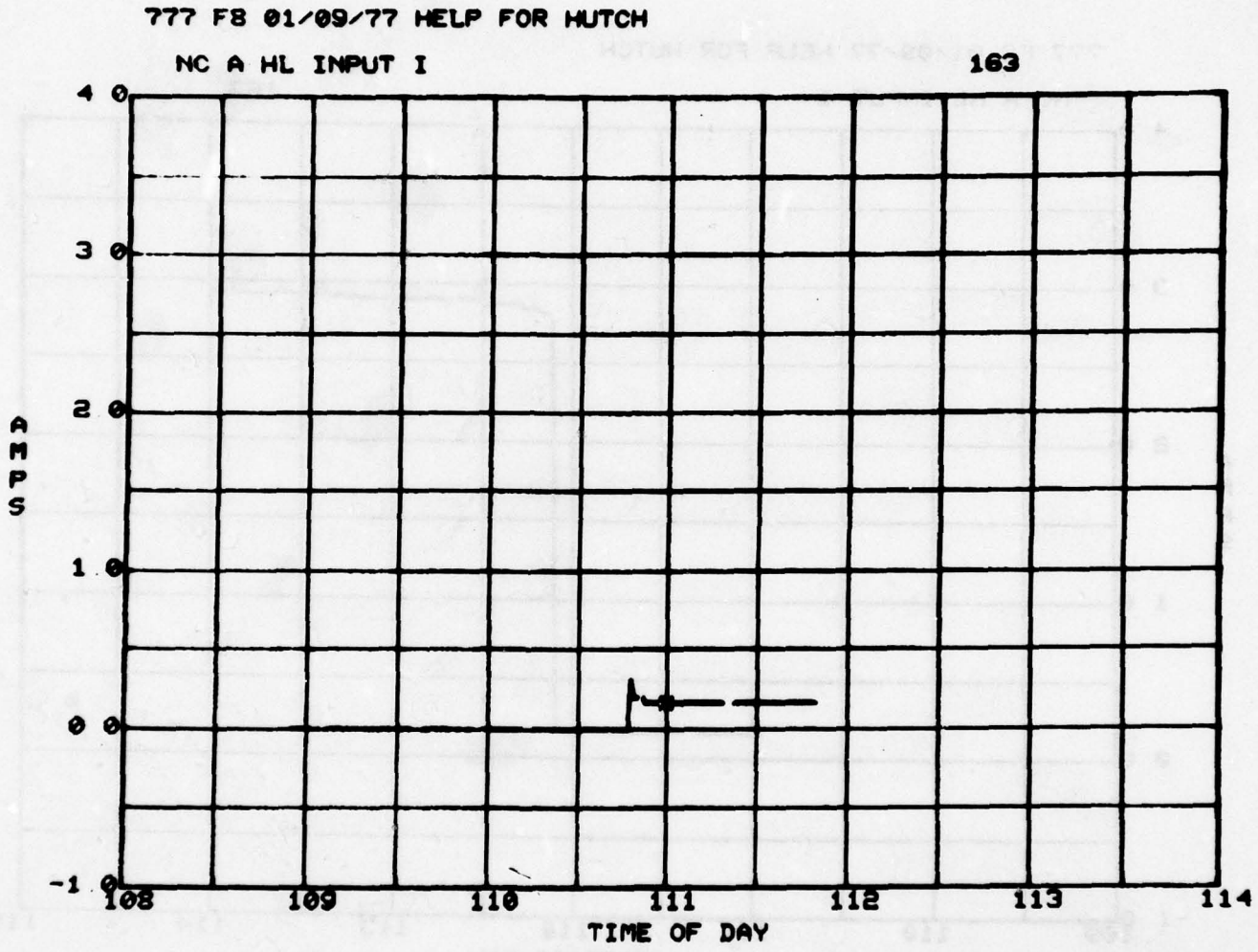
2.0
1.0
0 0
-1 0
AMPS
2213
2214
2215
2216
2217
2218
2219
TIME OF DAY

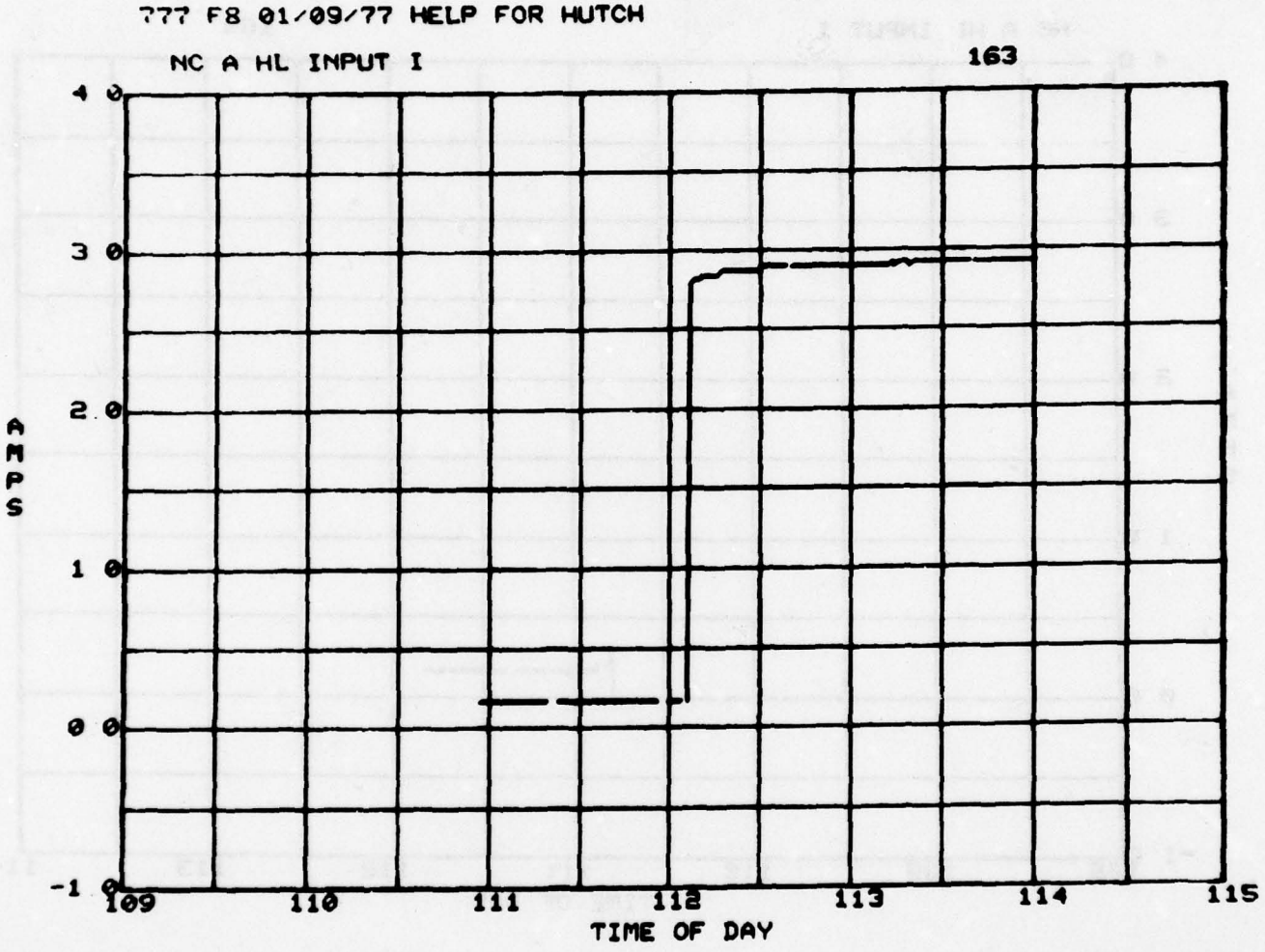

777 F8 01/08/77 HELP FOR HUTCH TV01
NC A HL INPUT I
163
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
2214
2215
2216
2217
2218
2219
2220
TIME OF DAY

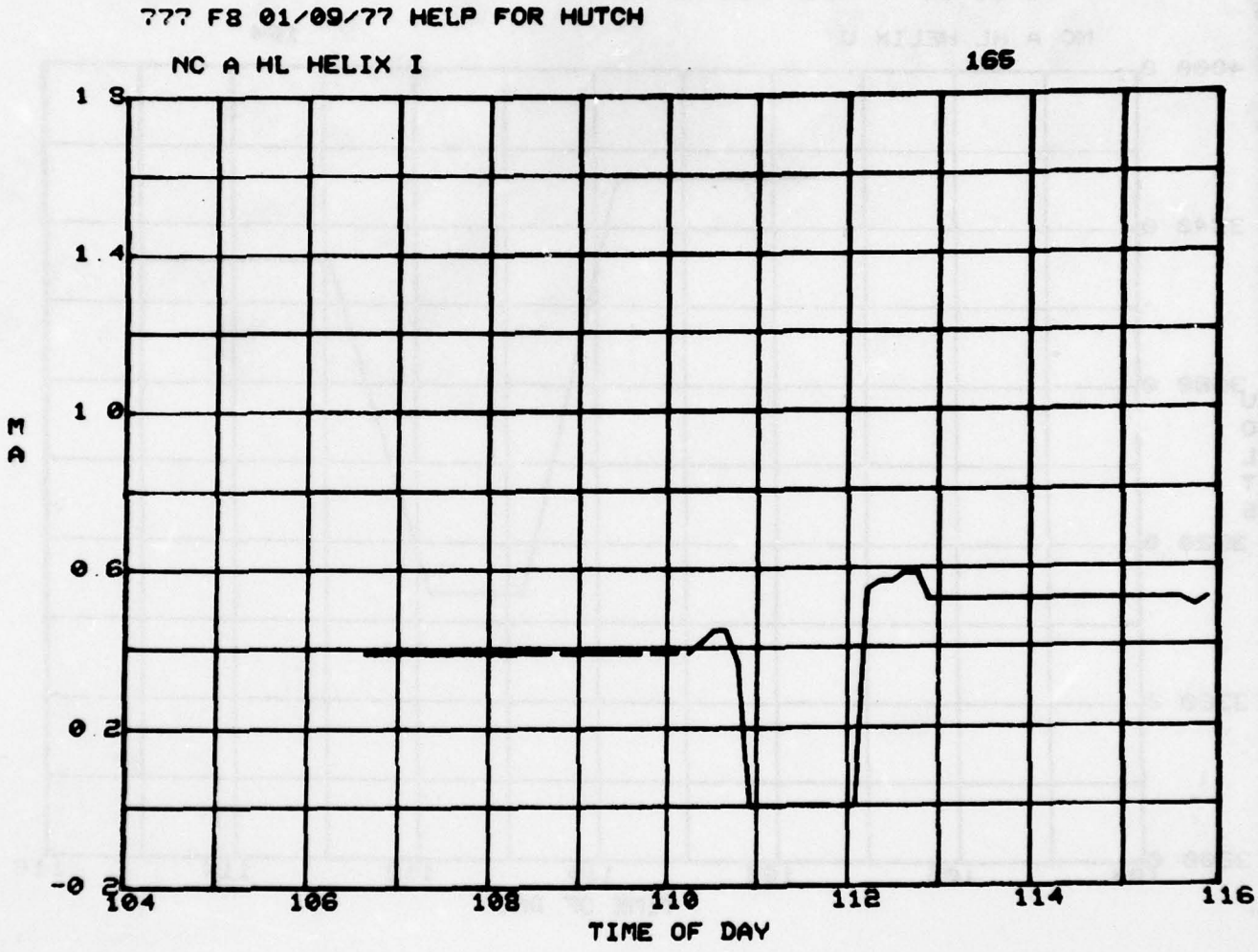

777 F8 01/08/77 HELP FOR HUTCH TV01
NC A HL HELIX I
165
1 8
1 4
1.0
0.6
0 2
-0 2
MA
2209
2211
2213
2215
2217
2219
2221
TIME OF DAY

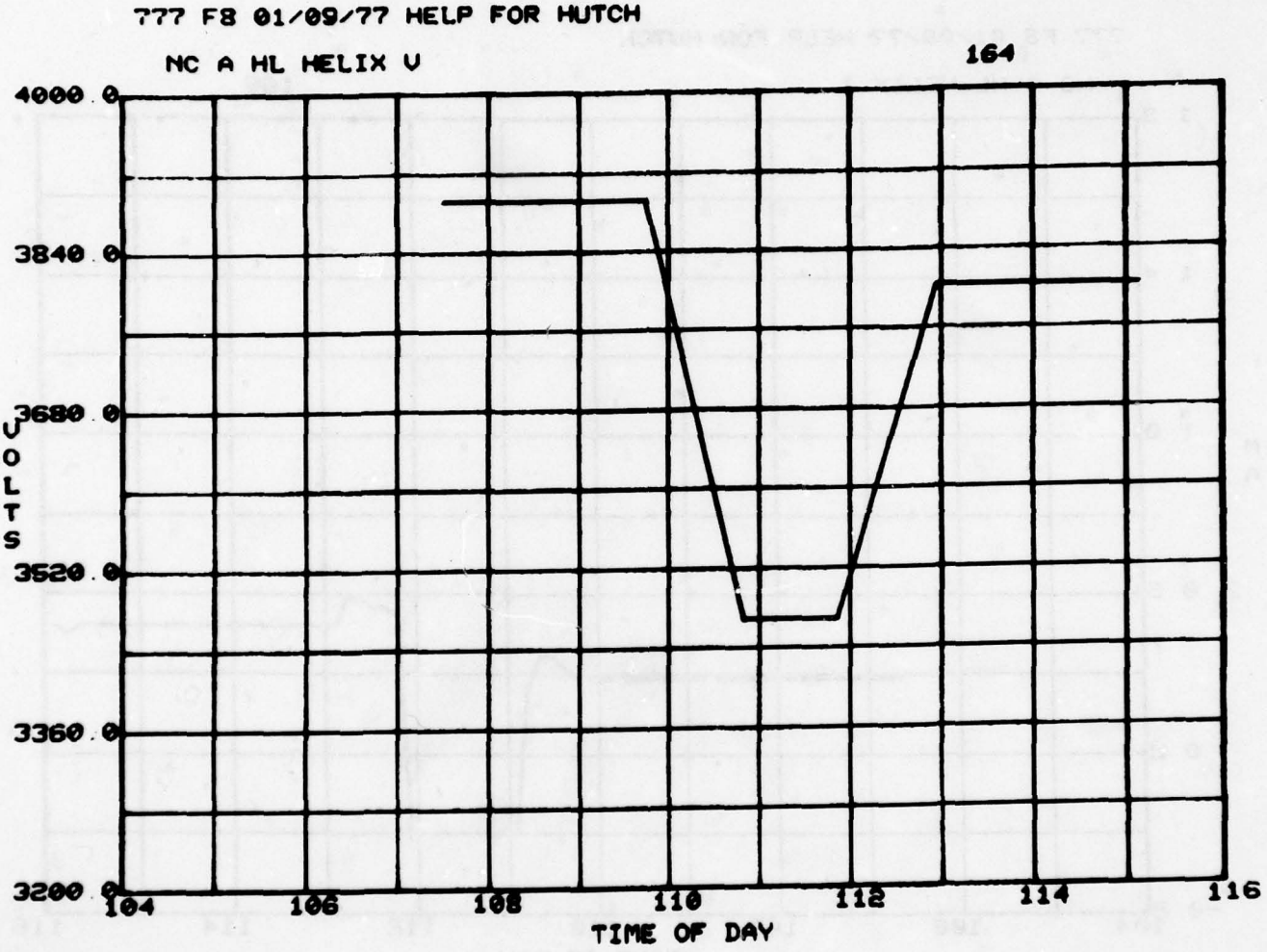

777 F8 01/08/77 HELP FOR HUTCH TV01
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
2209
2211
2213
2215
2217
2219
2221
TIME OF DAY


777 F8 01/08/77 HELP FOR HUTCH TV01
NC A HL HELIX V
164
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
2209
2211
2213
2215
2217
2219
2221
TIME OF DAY


777 F8 01/09/77 HELP FOR HUTCH
NC A HL INPUT I
163
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
108
109
110
111
112
113
114
TIME OF DAY

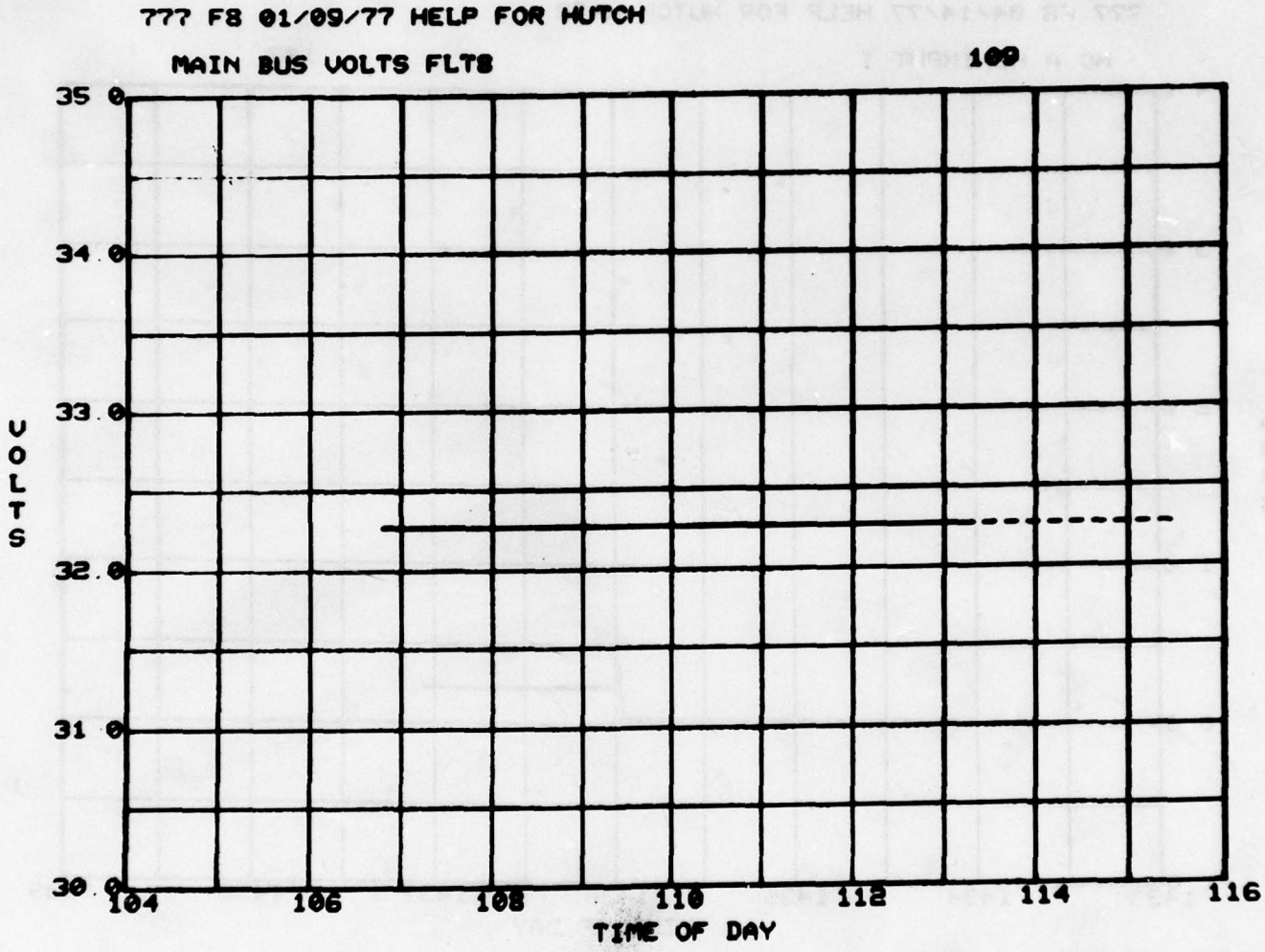

777 F8 01/09/77 HELP FOR HUTCH
NC A HL INPUT I
163
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
109
110
111
112
113
114
115
TIME OF DAY

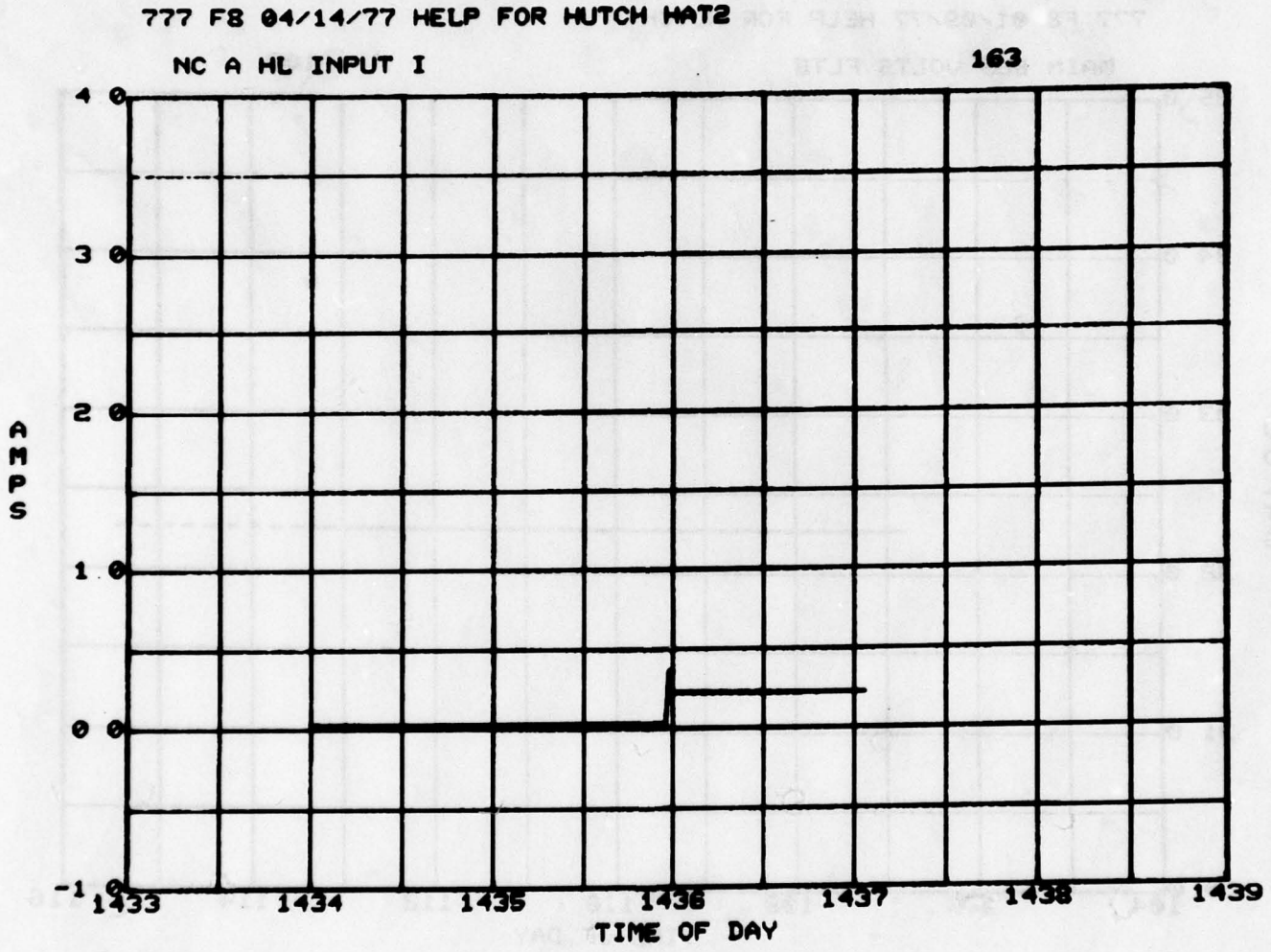

??? F8 01/09/77 HELP FOR HUTCH
NC A HL HELIX I
165
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
104
106
108
110
112
114
116
TIME OF DAY

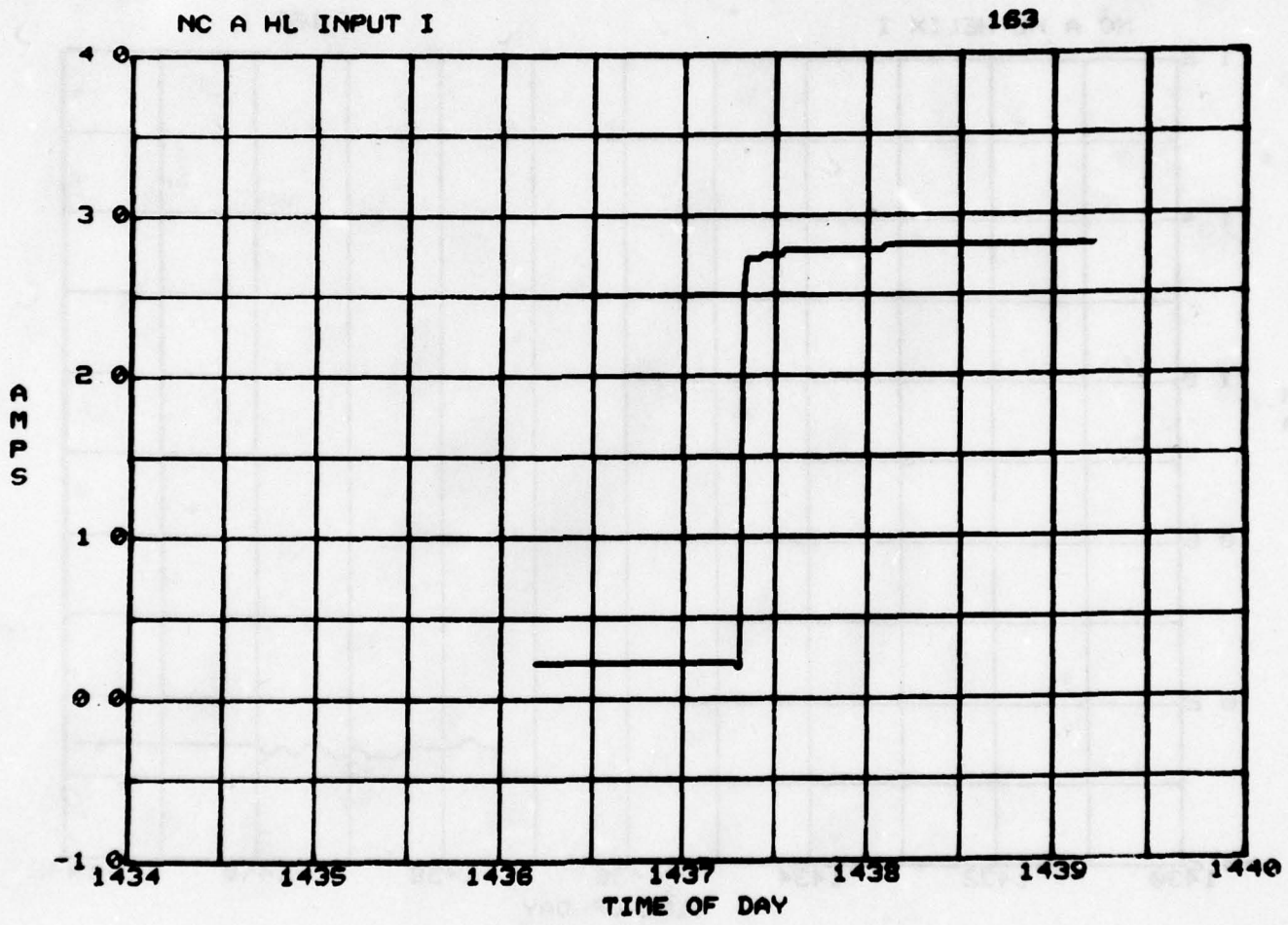

777 F8 01/09/77 HELP FOR HUTCH
NC A HL HELIX V
164
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
104
106
108
110
112
114
116
TIME OF DAY

AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

4 OF 7
AD A062 052


777 F8 01/09/77 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
100
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
104
106
108
110
112
114
116
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL INPUT I
163
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
1433
1434
1435
1436
1437
1438
1439
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL INPUT I
163
4 0
3 0
2 0
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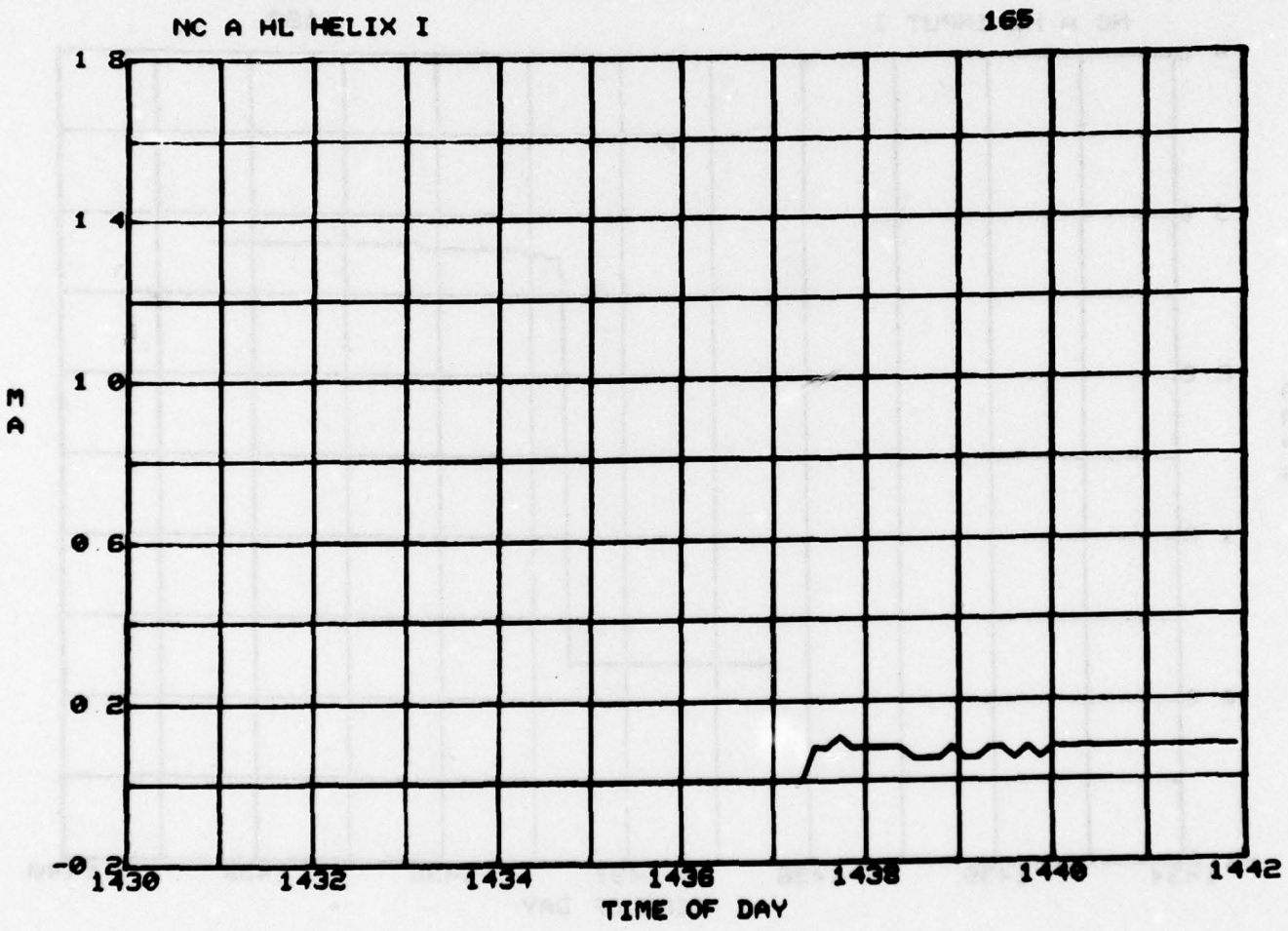
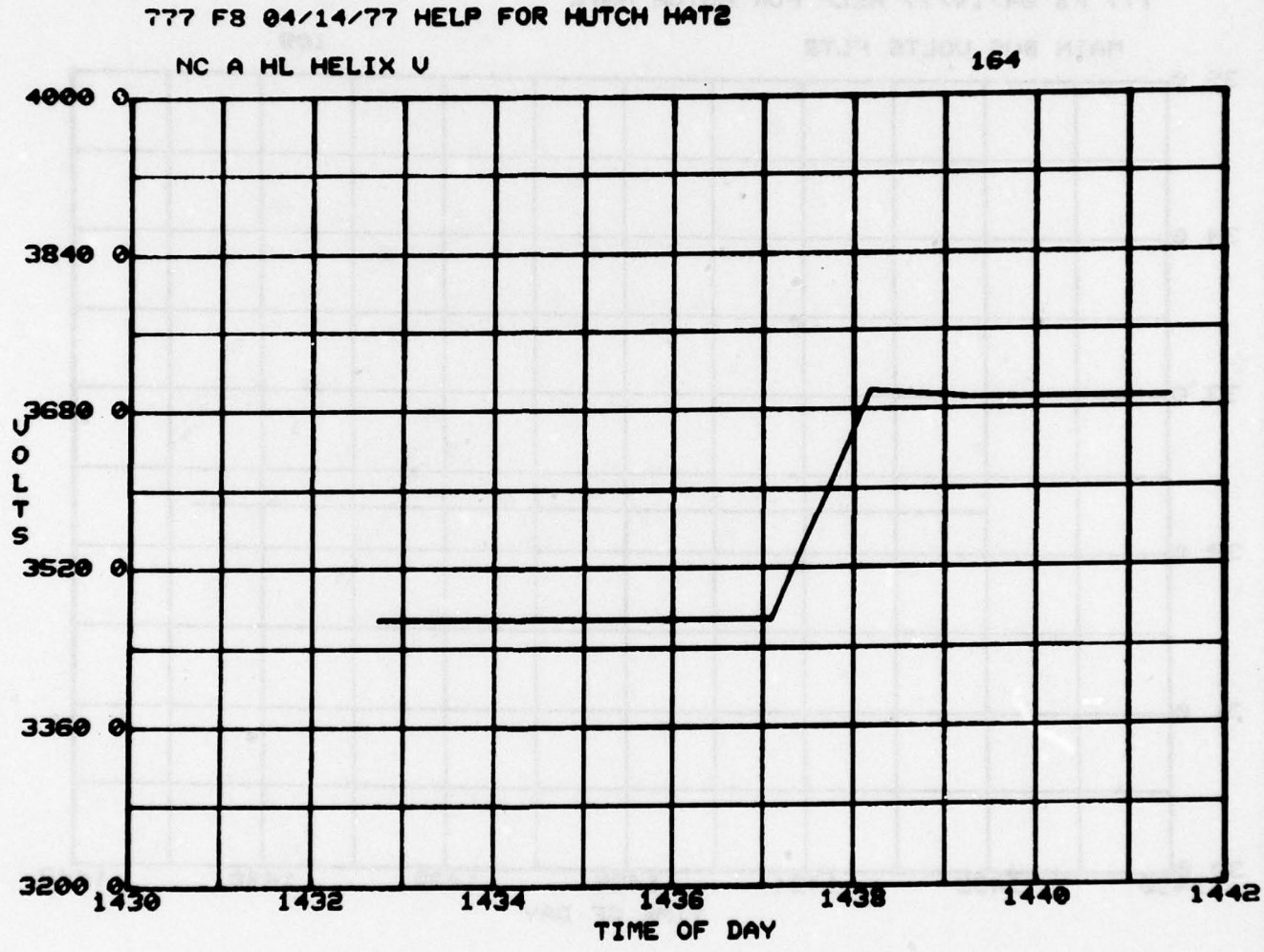
0 0
-1 0
AMPS
1434
1435
1436
1437
1438
1439
1440
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL HELIX I
165
1 8
1 4
1 0
0 6
0 2
-0 2
M
A
1430
1432
1434
1436
1438
1440
1442
TIME OF DAY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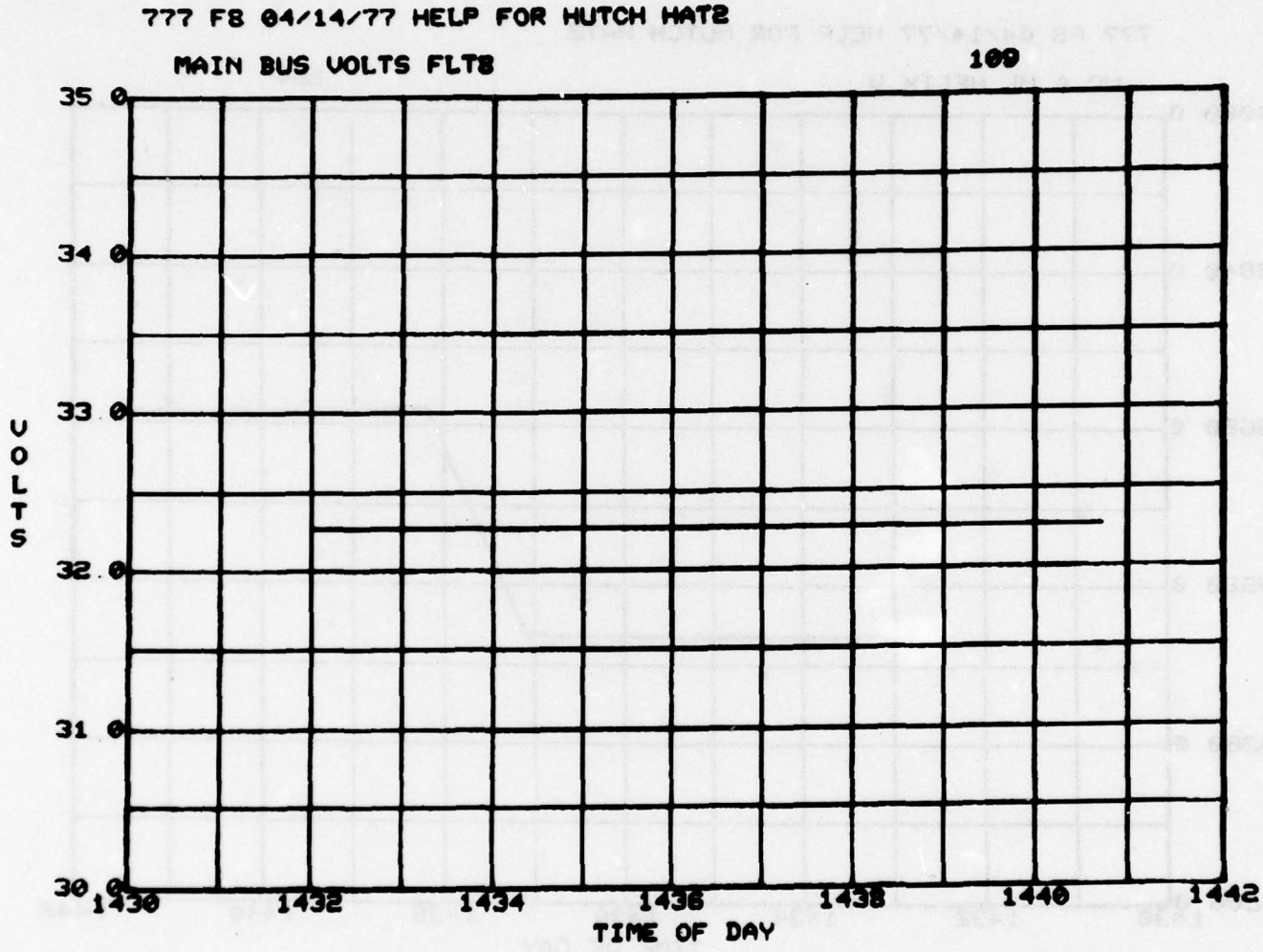
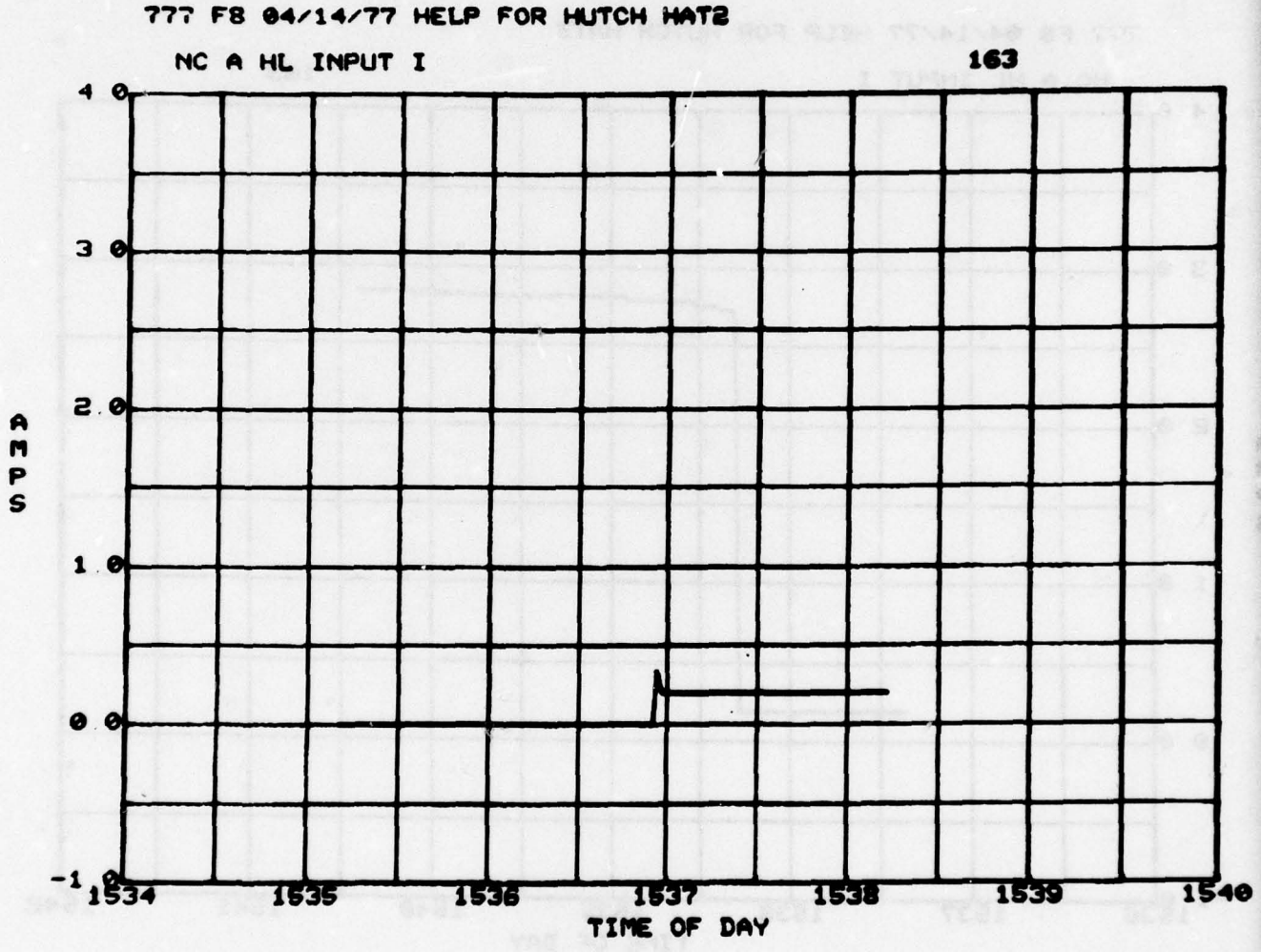
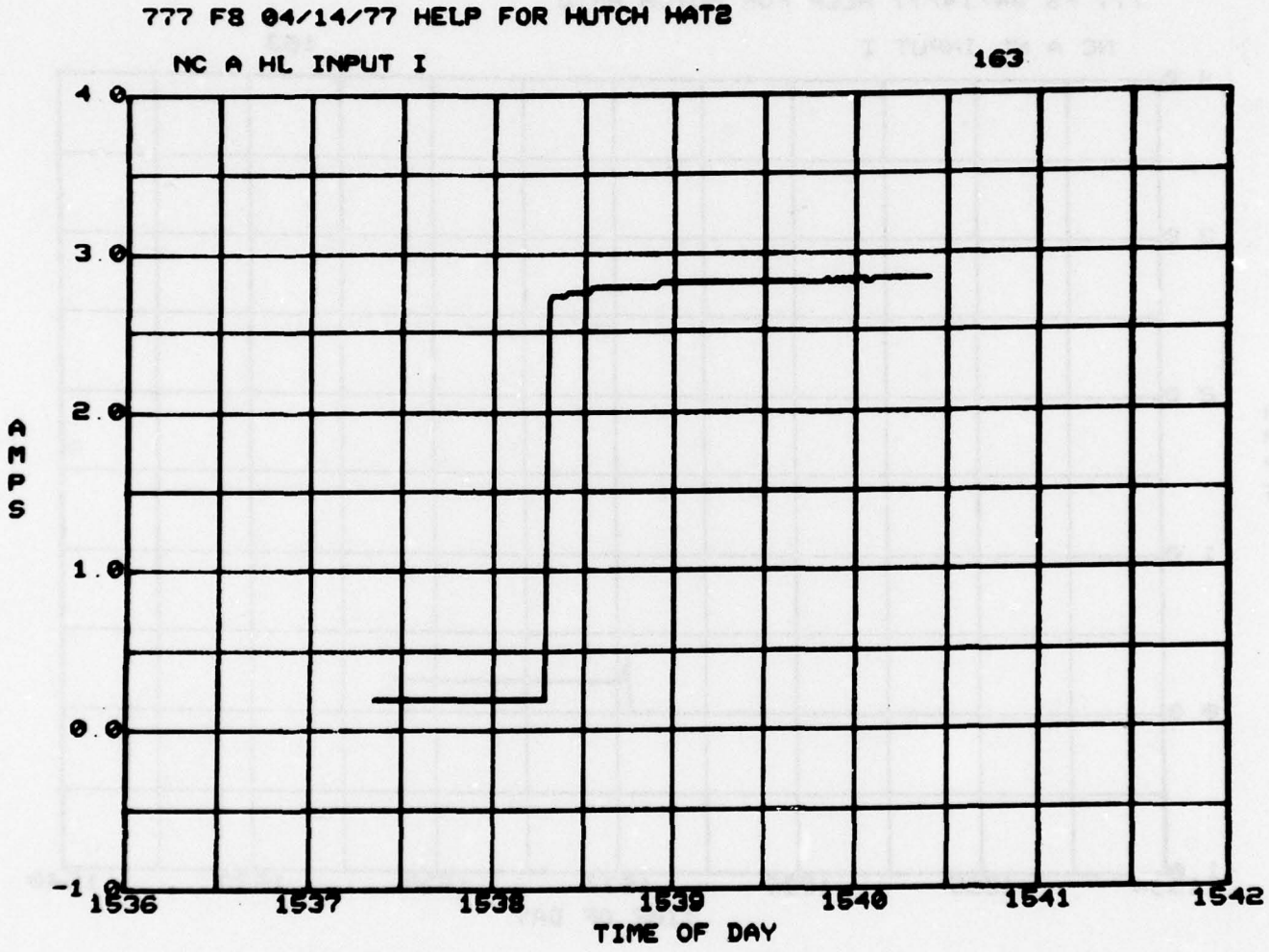
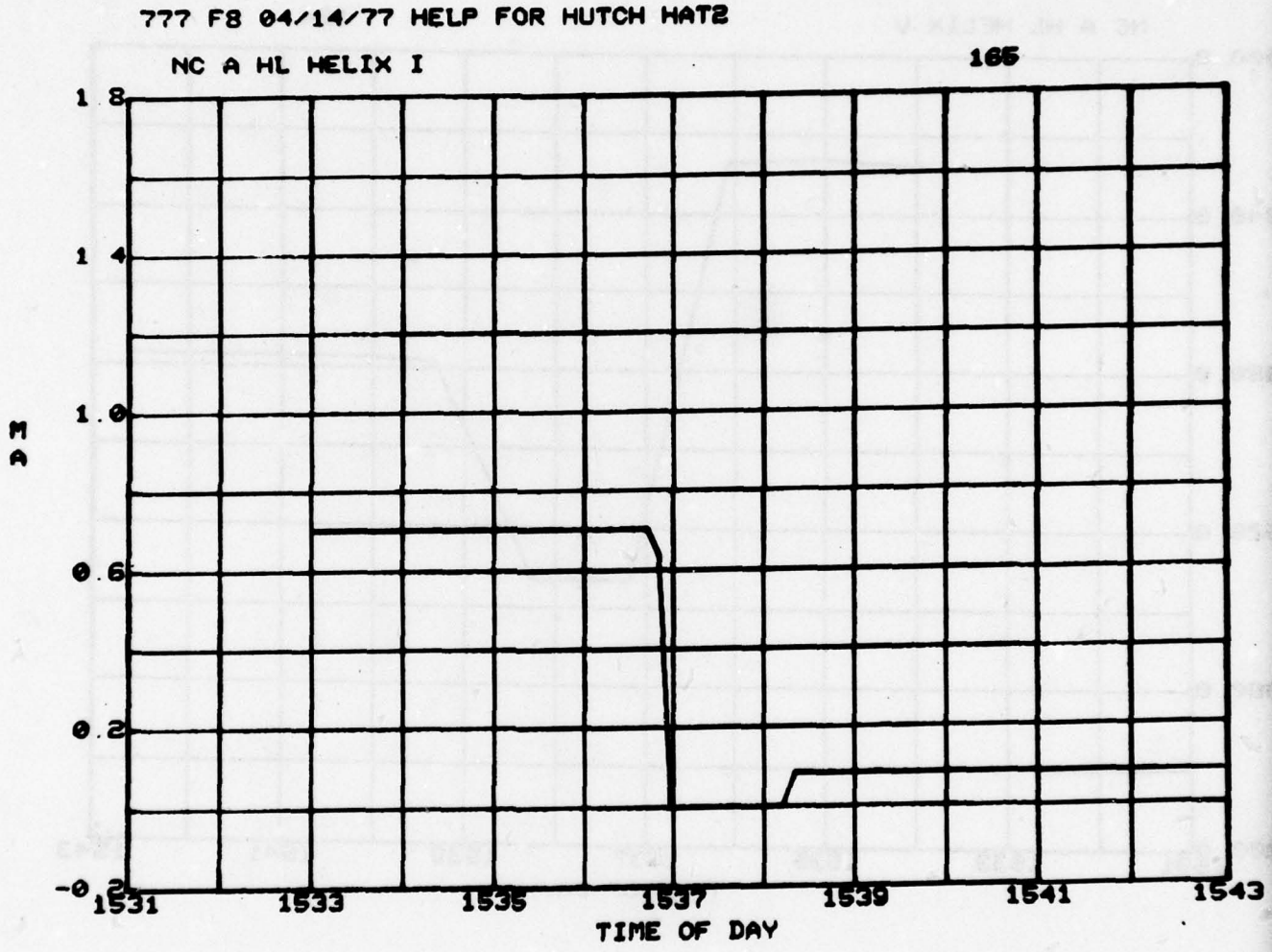
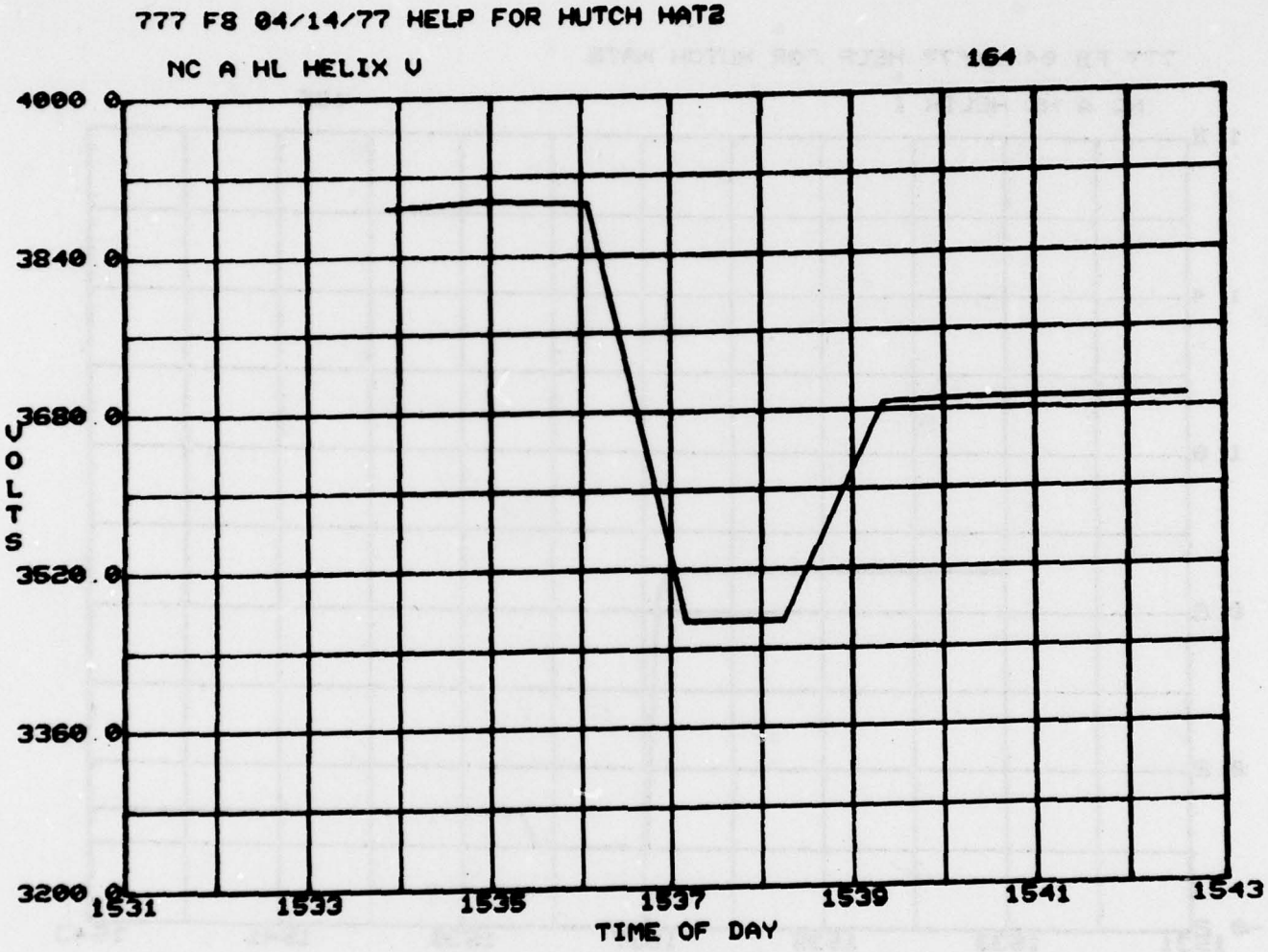
NC A HL HELIX V
164
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
1430
1432
1434
1436
1438
1440
1442
TIME OF DAY

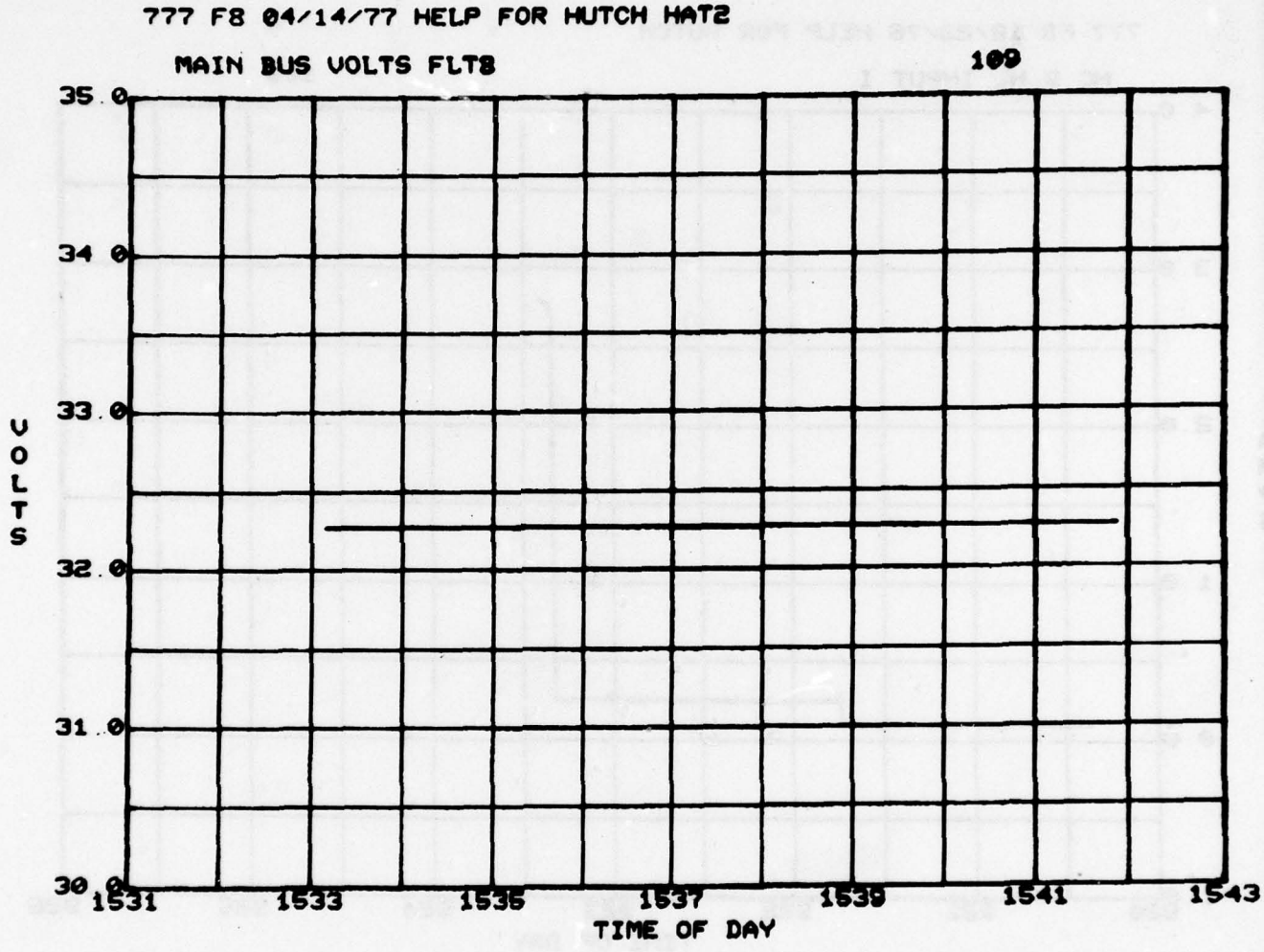

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
100
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
1430
1432
1434
1436
1438
1440
1442
TIME OF DAY

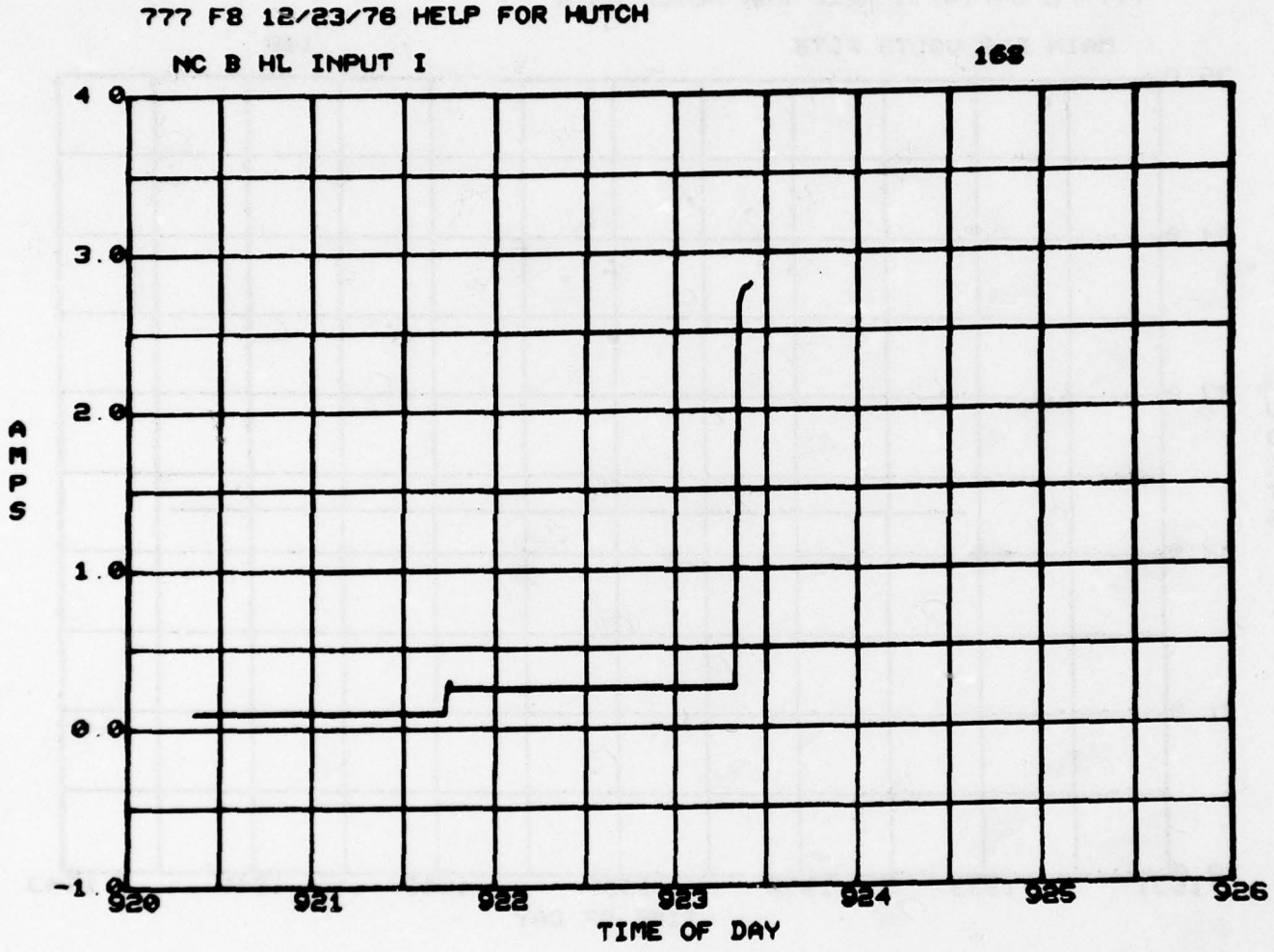

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1534
1535
1536
1537
1538
1539
1540
TIME OF DAY

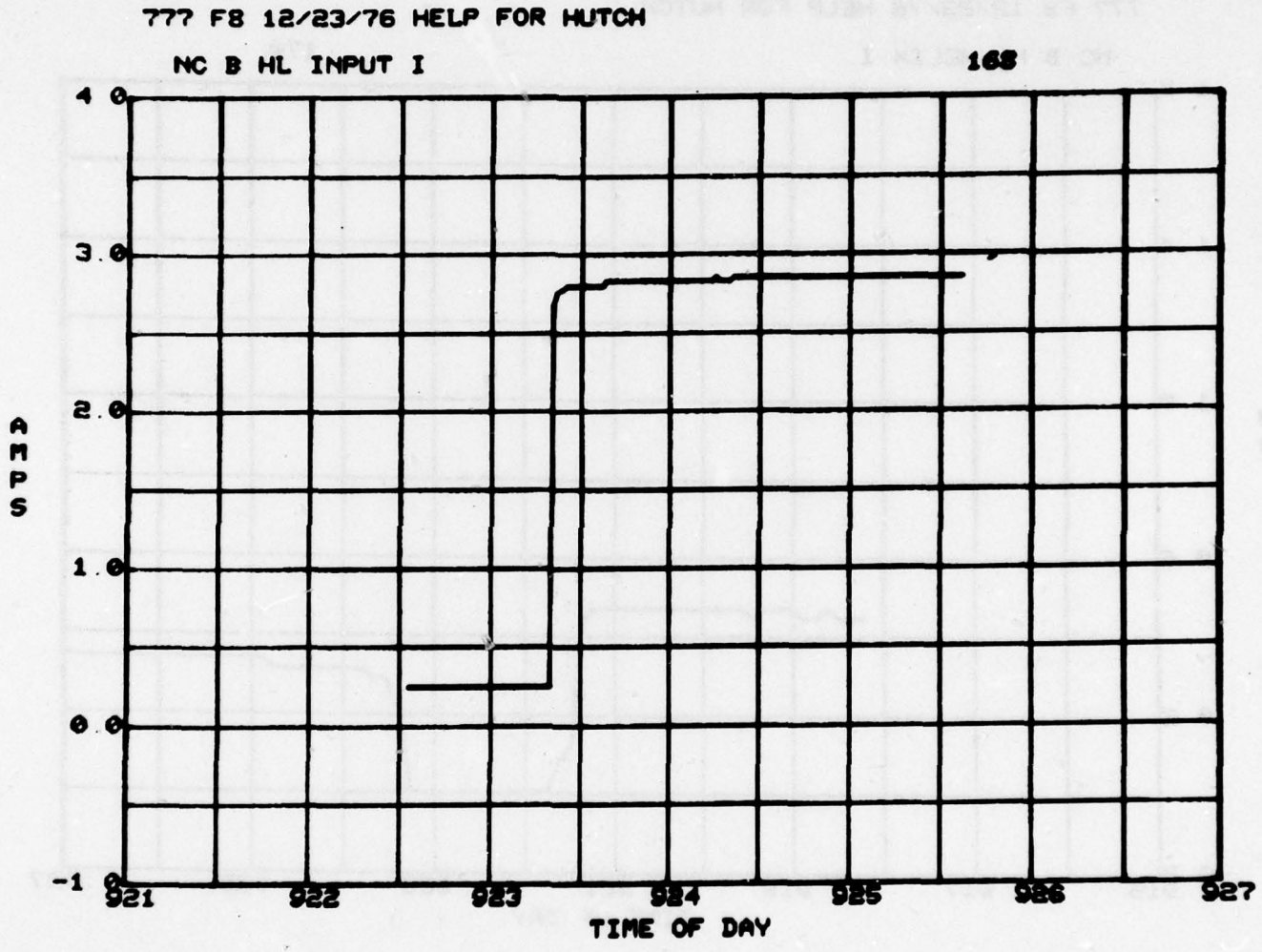

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL INPUT I
163
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1536
1537
1538
1539
1540
1541
1542
TIME OF DAY

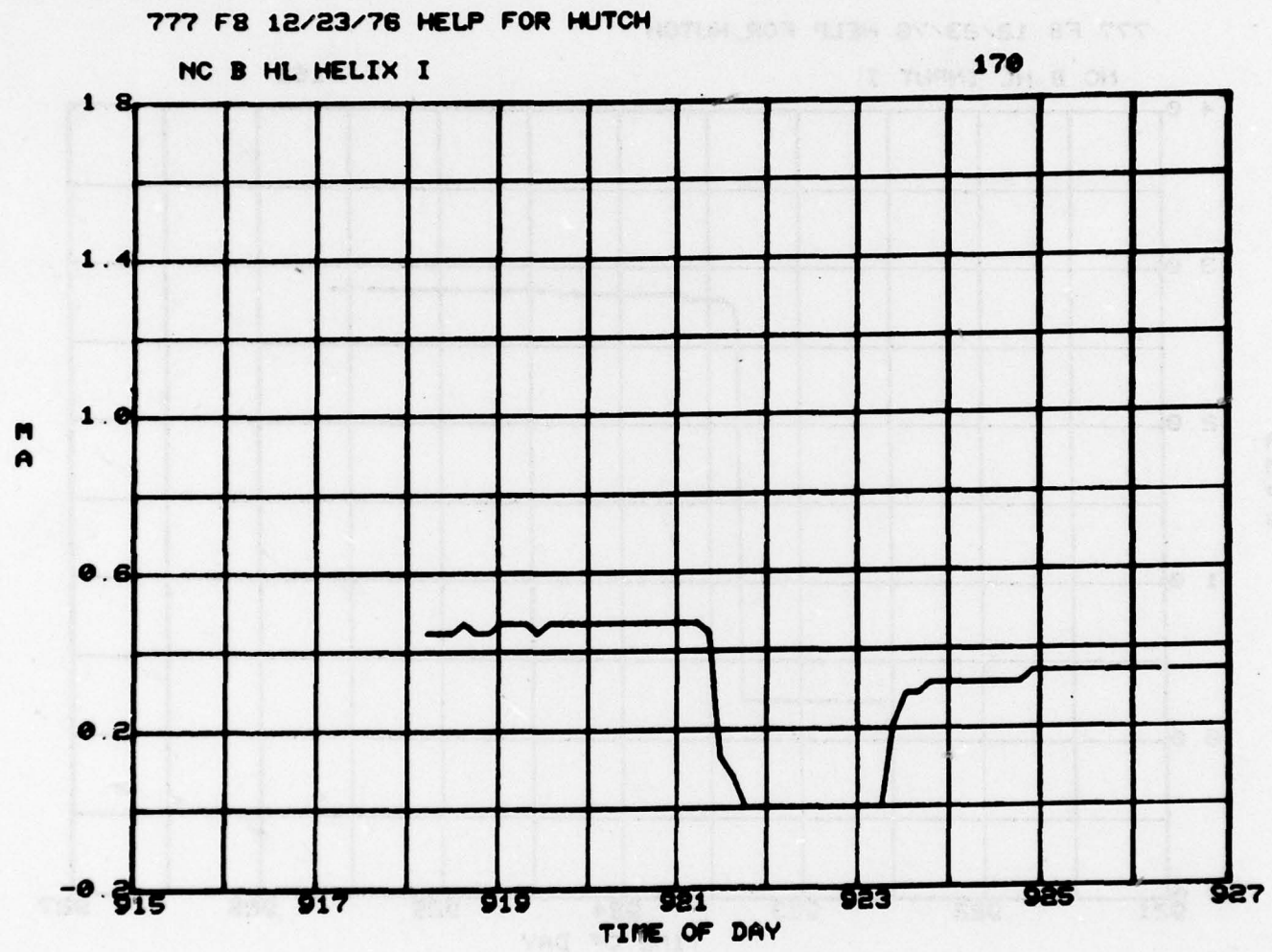

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC A HL HELIX I
165
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1531
1533
1535
1537
1539
1541
1543
TIME OF DAY

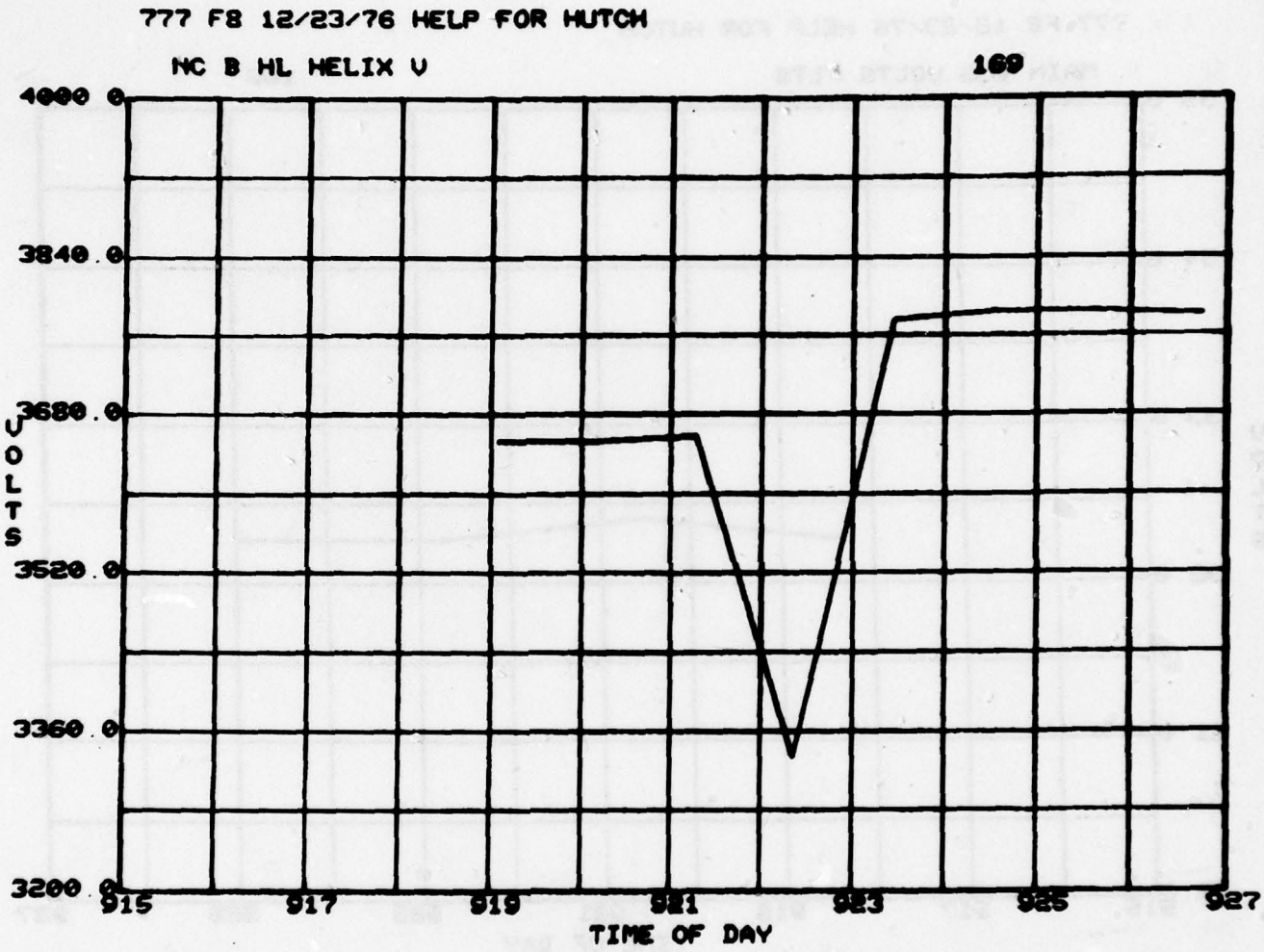

777 FS 04/14/77 HELP FOR HUTCH HAT2
NC A HL HELIX V
164
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1531
1533
1535
1537
1539
1541
1543
TIME OF DAY

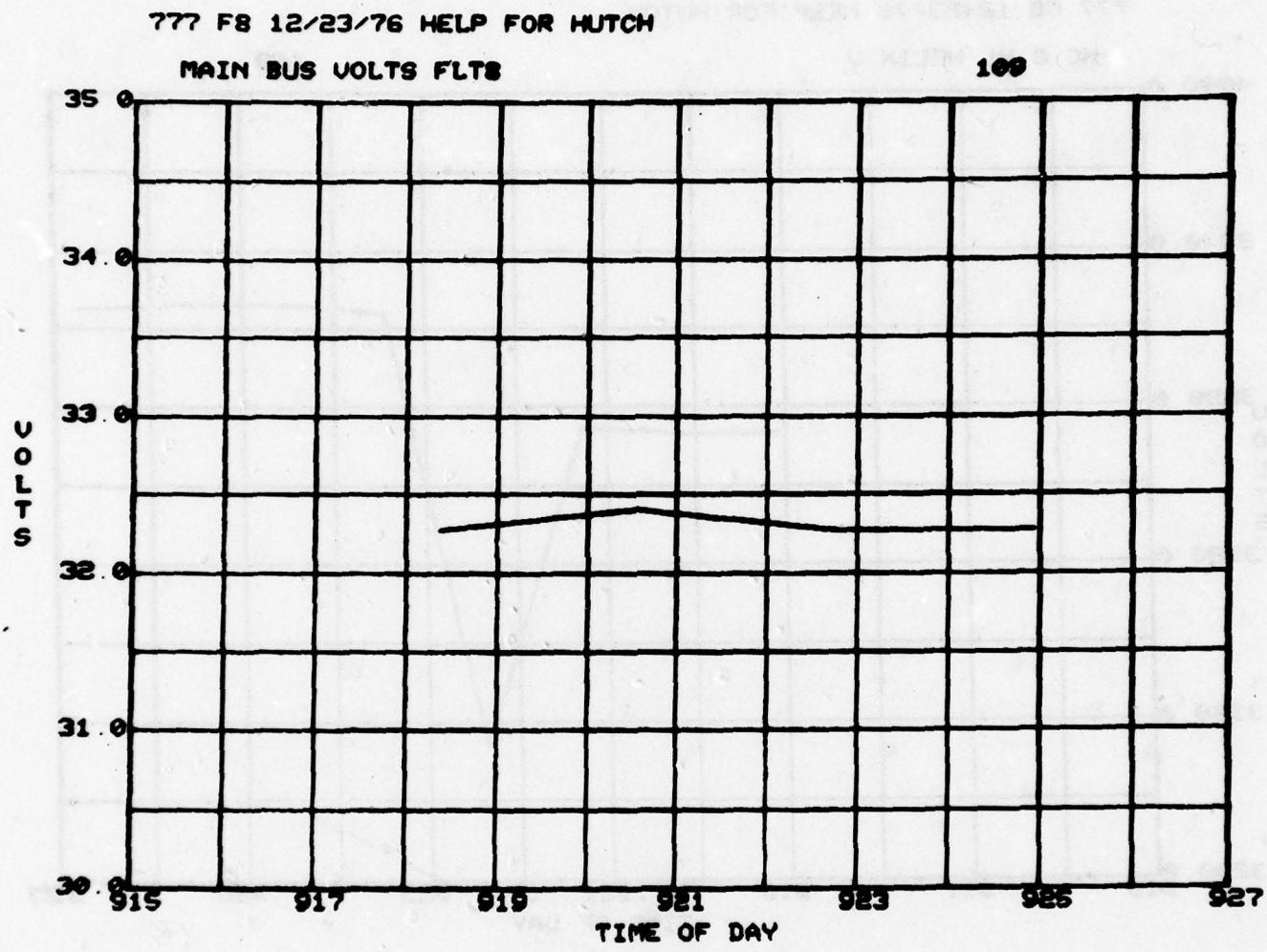

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1531
1533
1535
1537
1539
1541
1543
TIME OF DAY

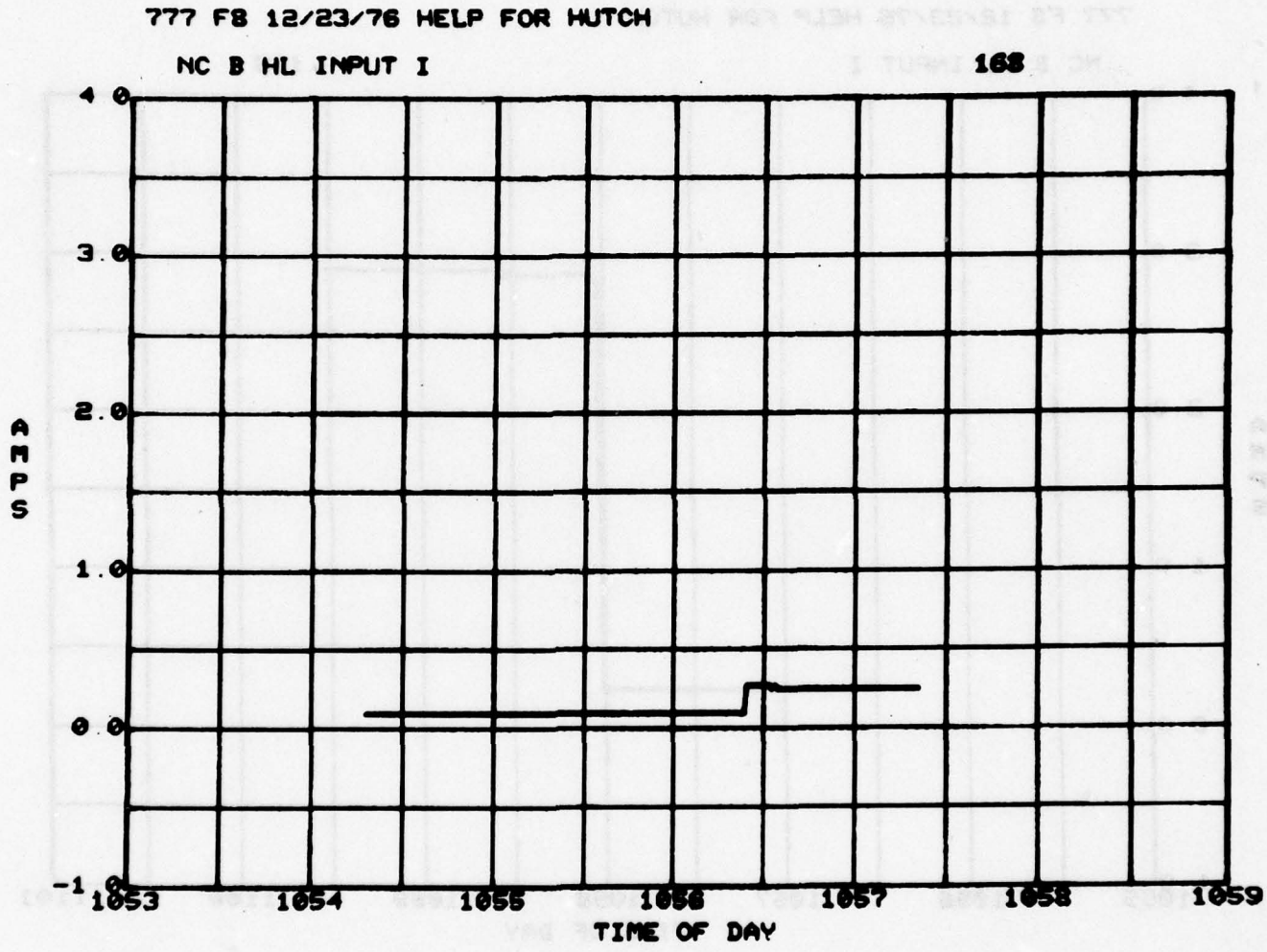

777 F8 12/23/76 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
920
921
922
923
924
925
926
TIME OF DAY

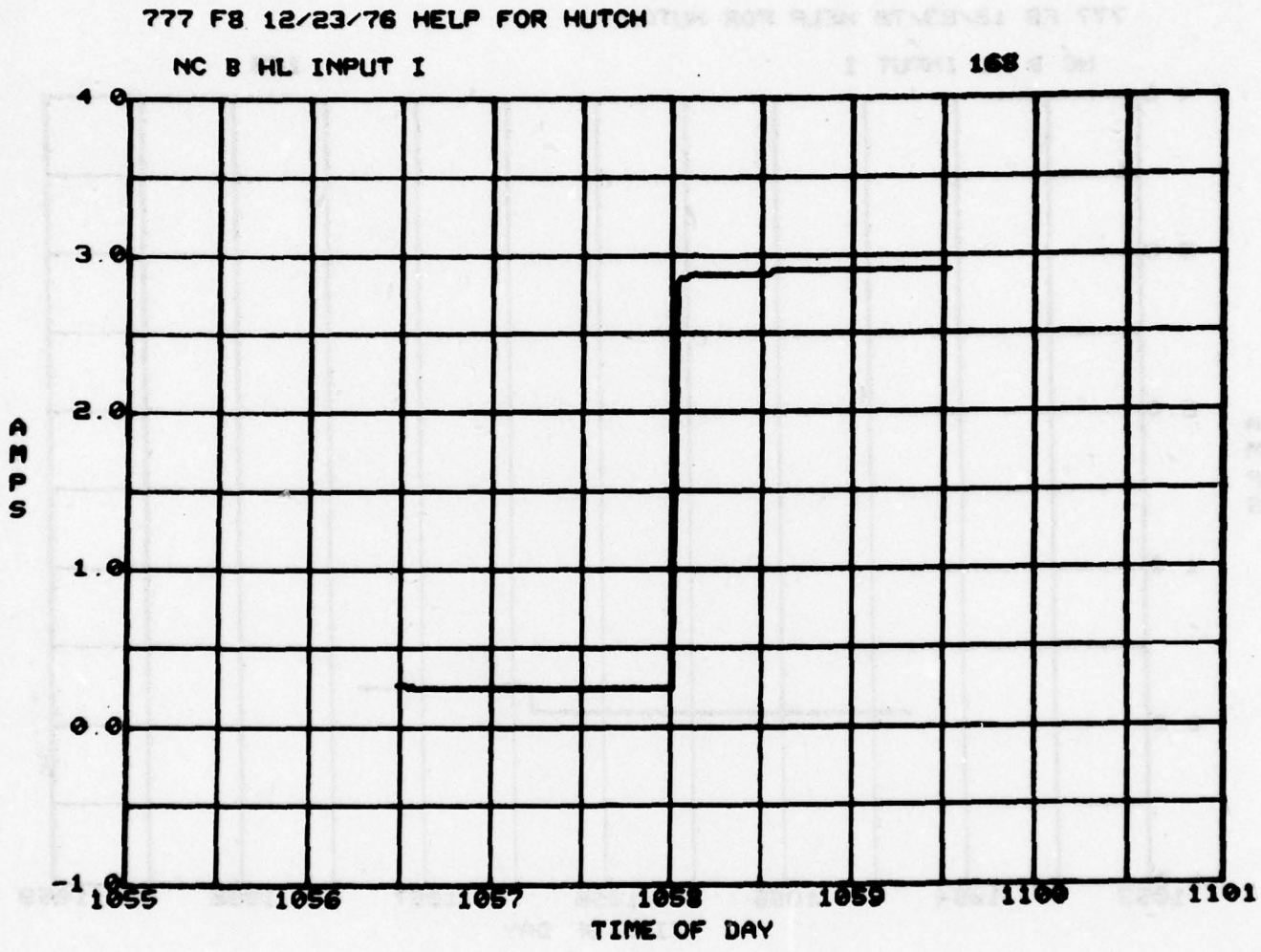

777 F8 12/23/76 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
921
922
923
924
925
926
927
TIME OF DAY

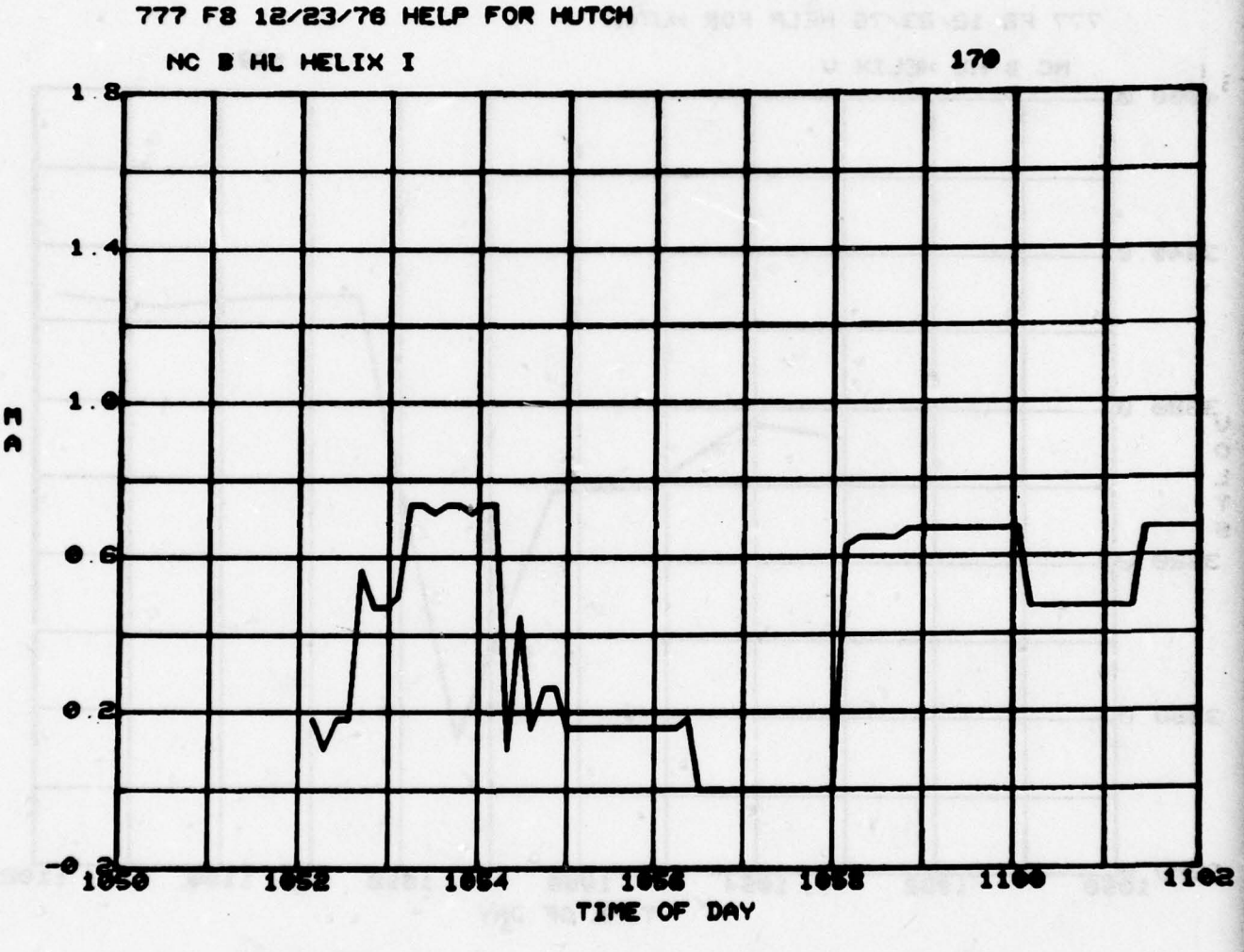

777 F8 12/23/76 HELP FOR HUTCH
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
915
917
919
921
923
925
927
TIME OF DAY

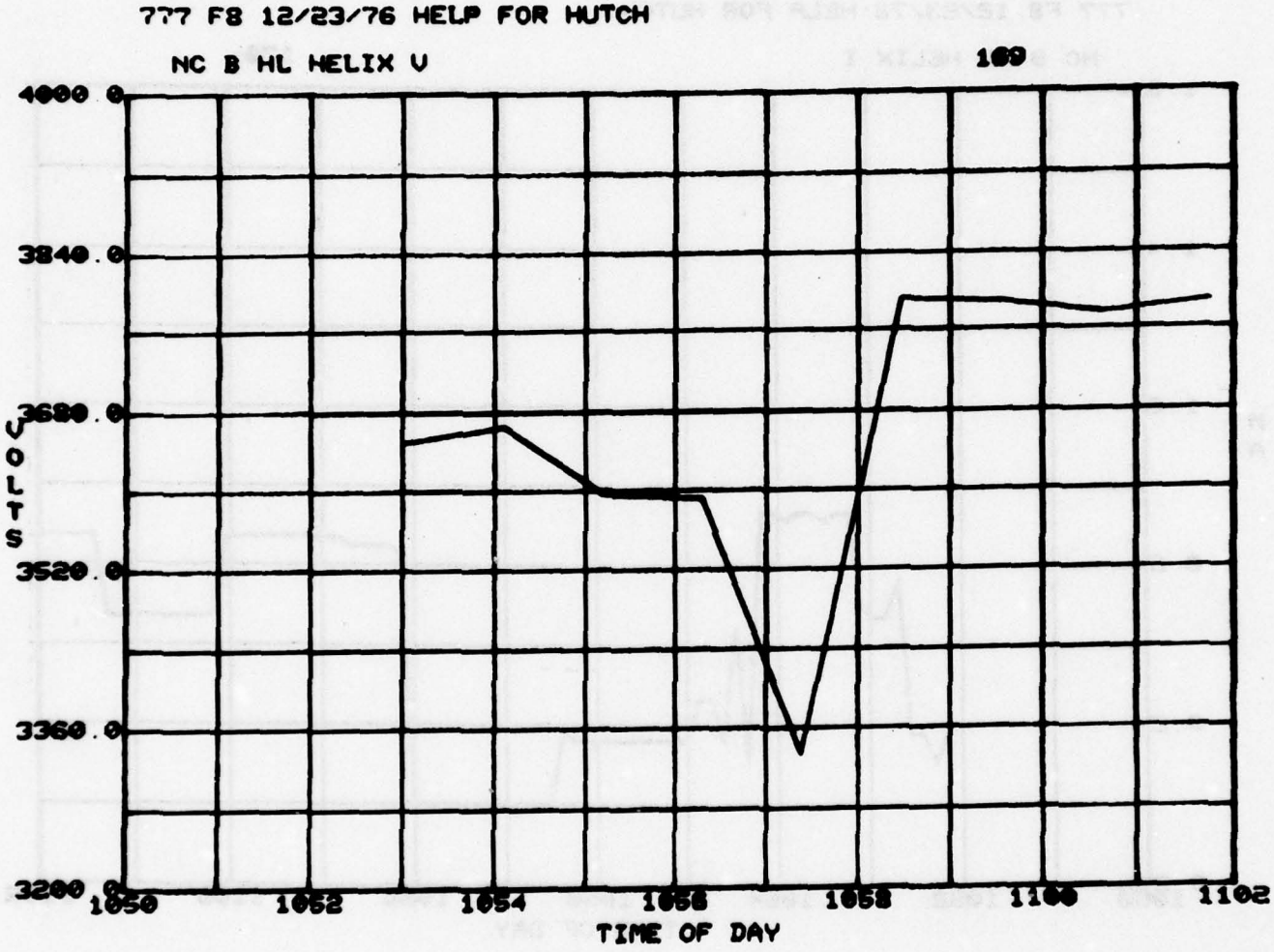

777 F8 12/23/76 HELP FOR HUTCH
NC B HL HELIX V
169
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
915
917
919
921
923
925
927
TIME OF DAY

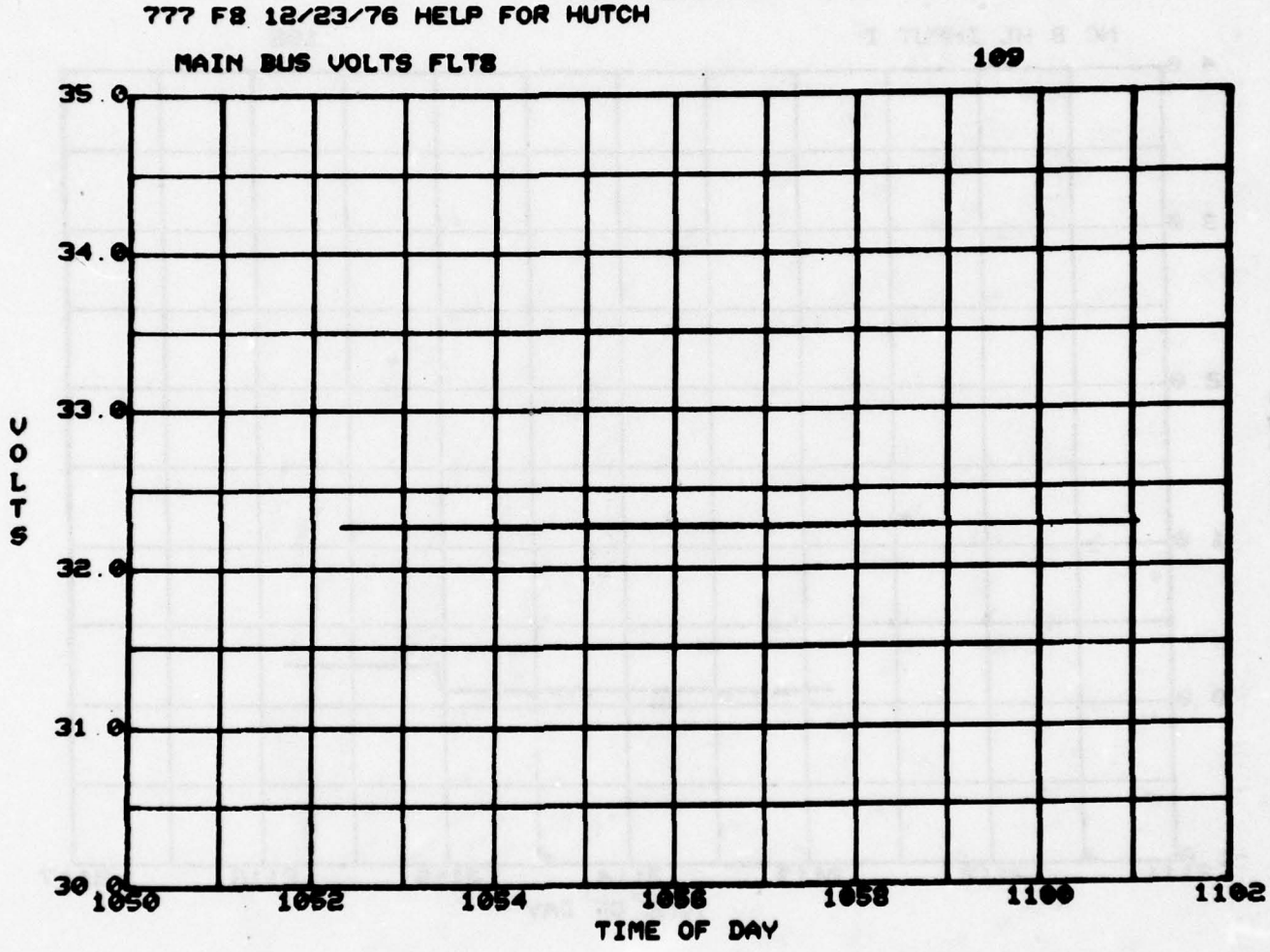

777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
100
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
915
917
919
921
923
925
927
TIME OF DAY

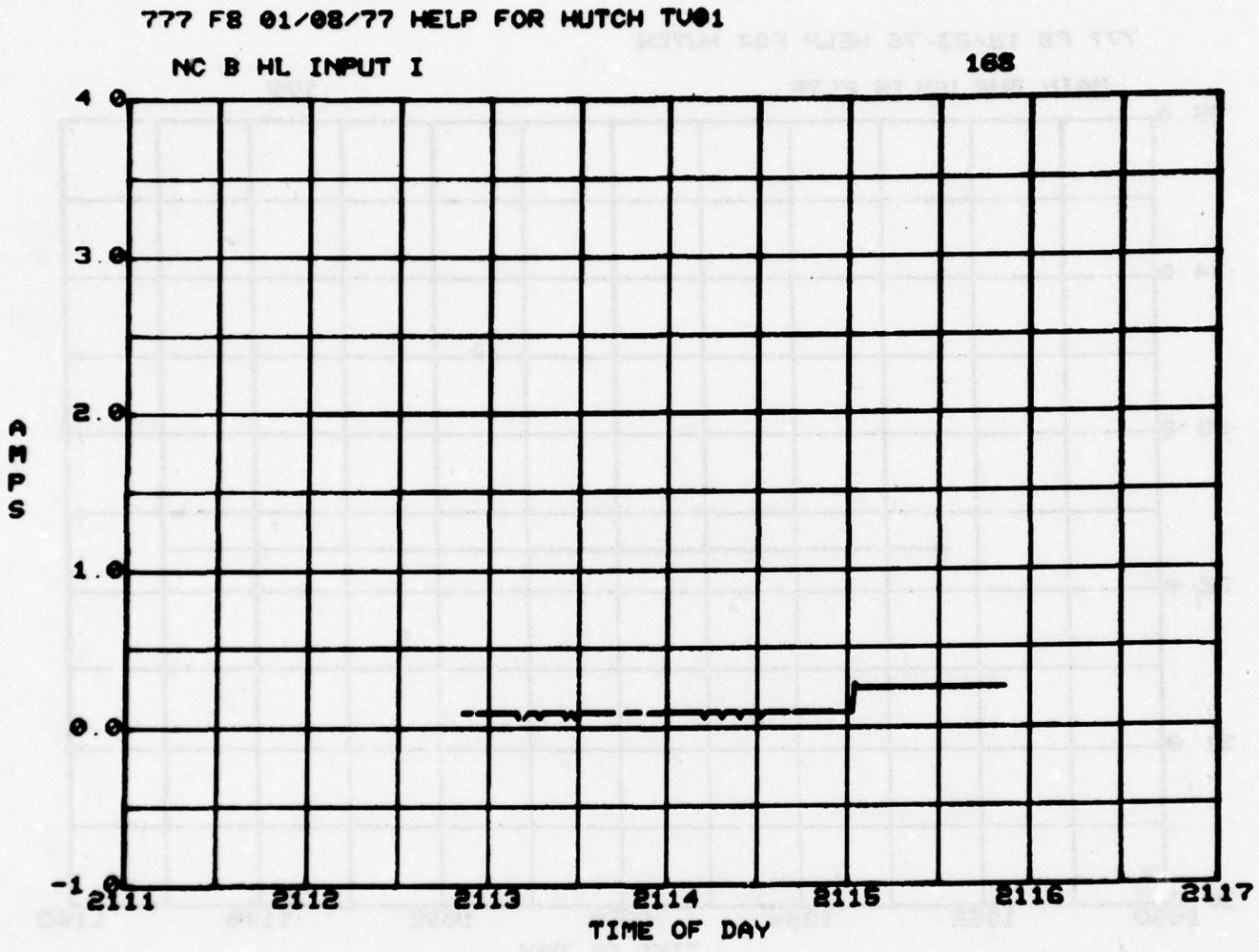

777 F8 12/23/76 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1053
1054
1055
1056
1057
1058
1059
TIME OF DAY

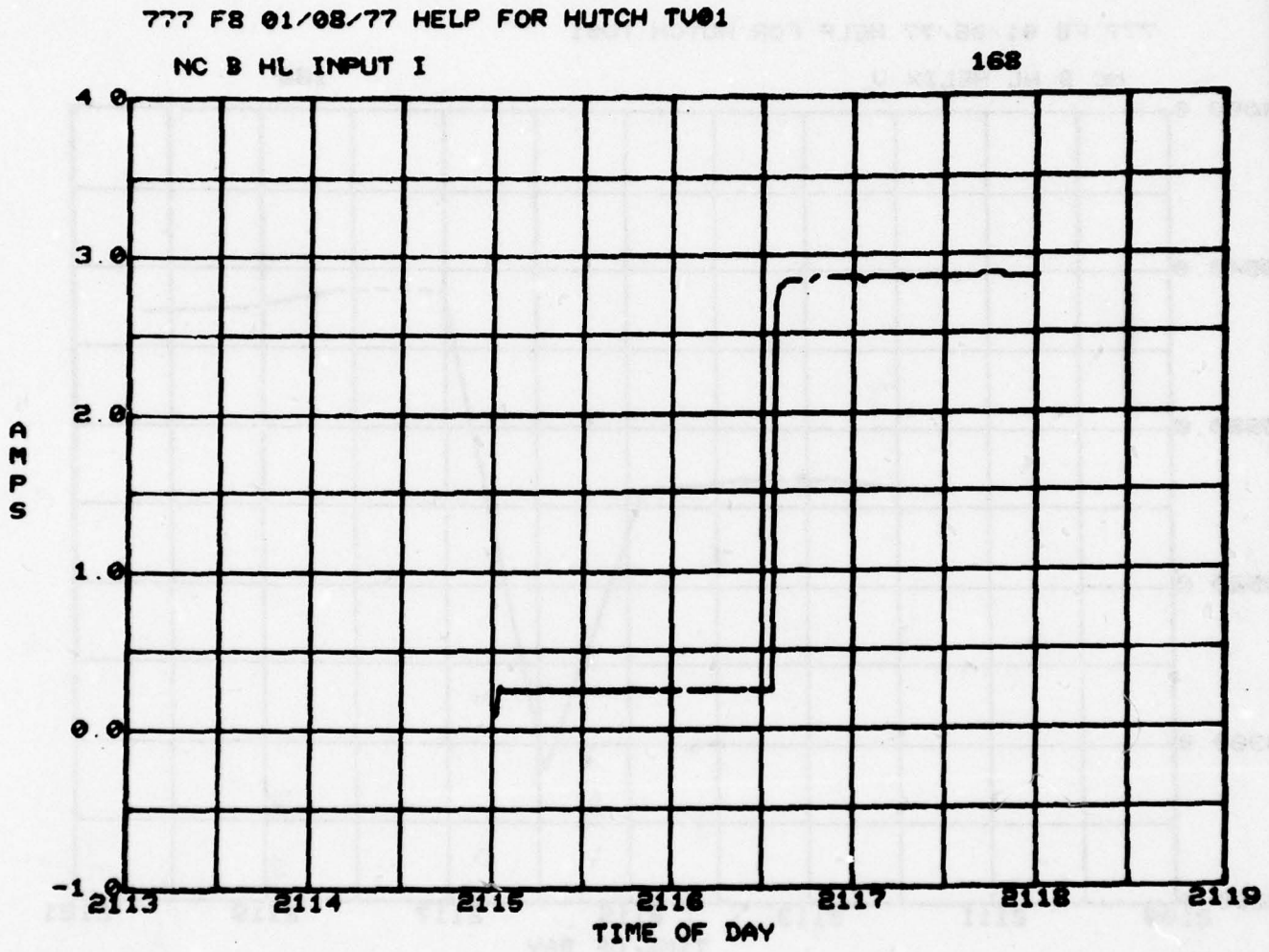

777 F8 12/23/76 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1055
1056
1057
1058
1059
1100
1101
TIME OF DAY

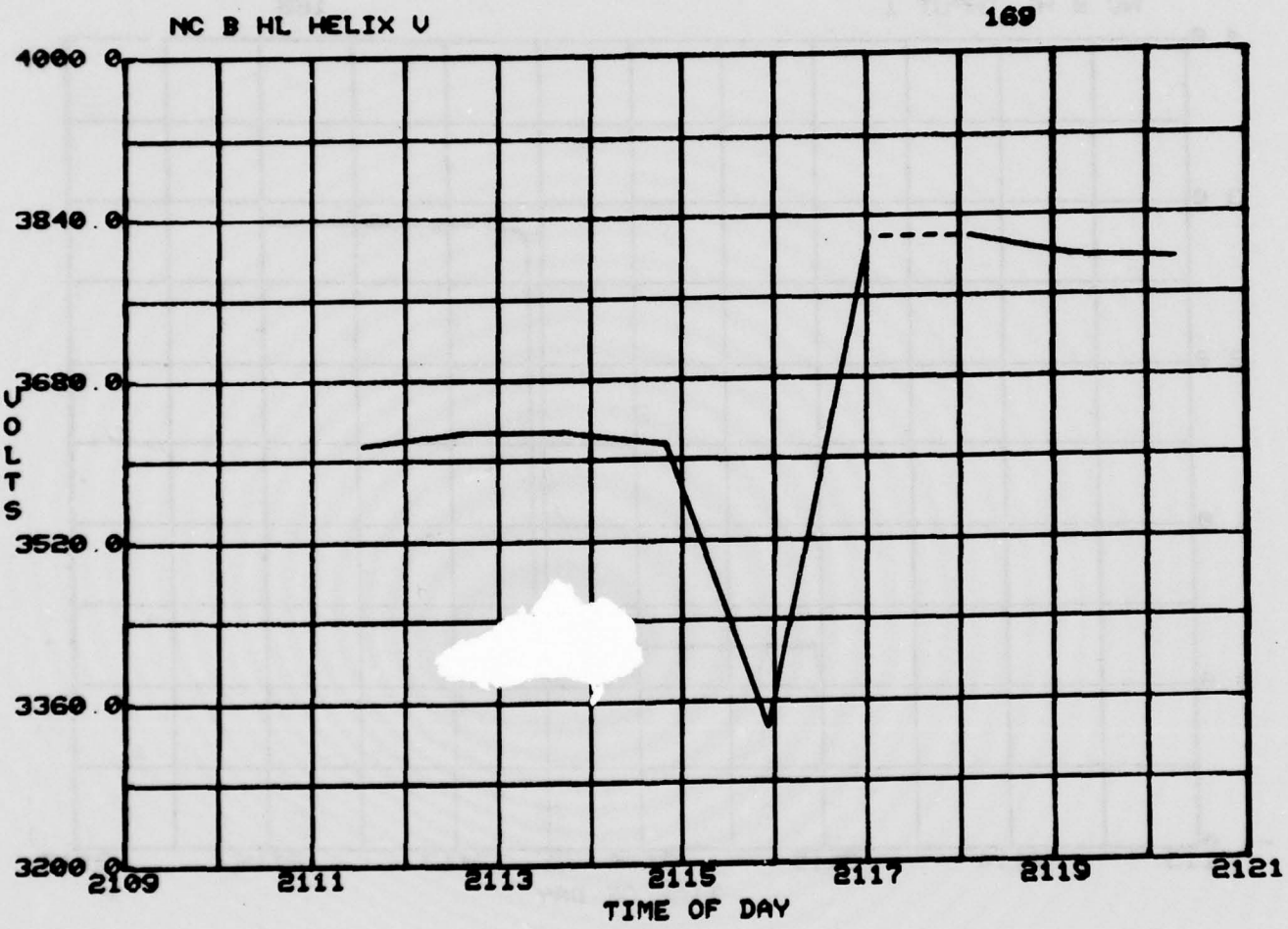

777 F8 12/23/78 HELP FOR HUTCH
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1050
1052
1054
1056
1058
1100
1102
TIME OF DAY

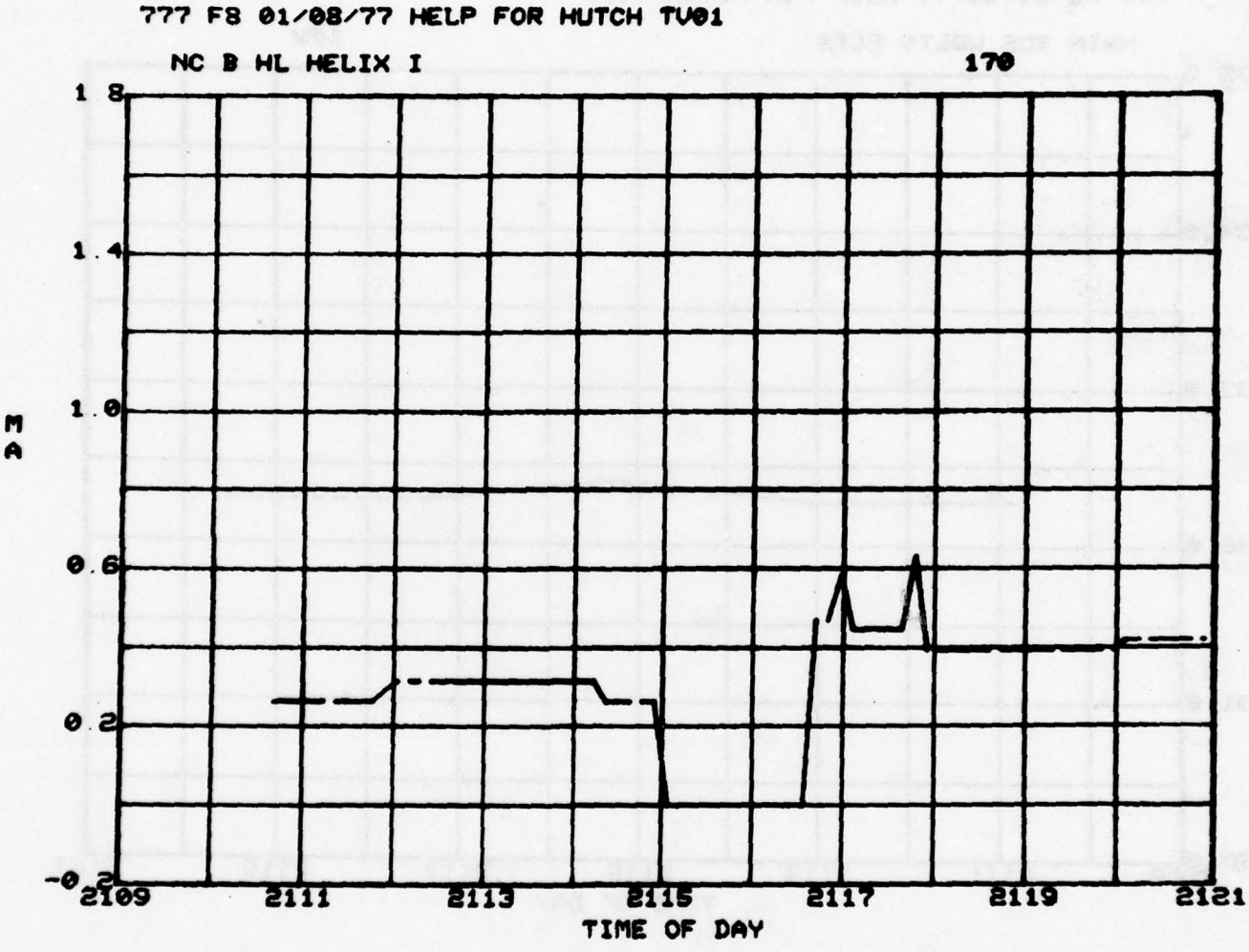

777 F8 12/23/76 HELP FOR HUTCH
NC B HL HELIX V
100
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1050
1052
1054
1056
1058
1100
1102
TIME OF DAY

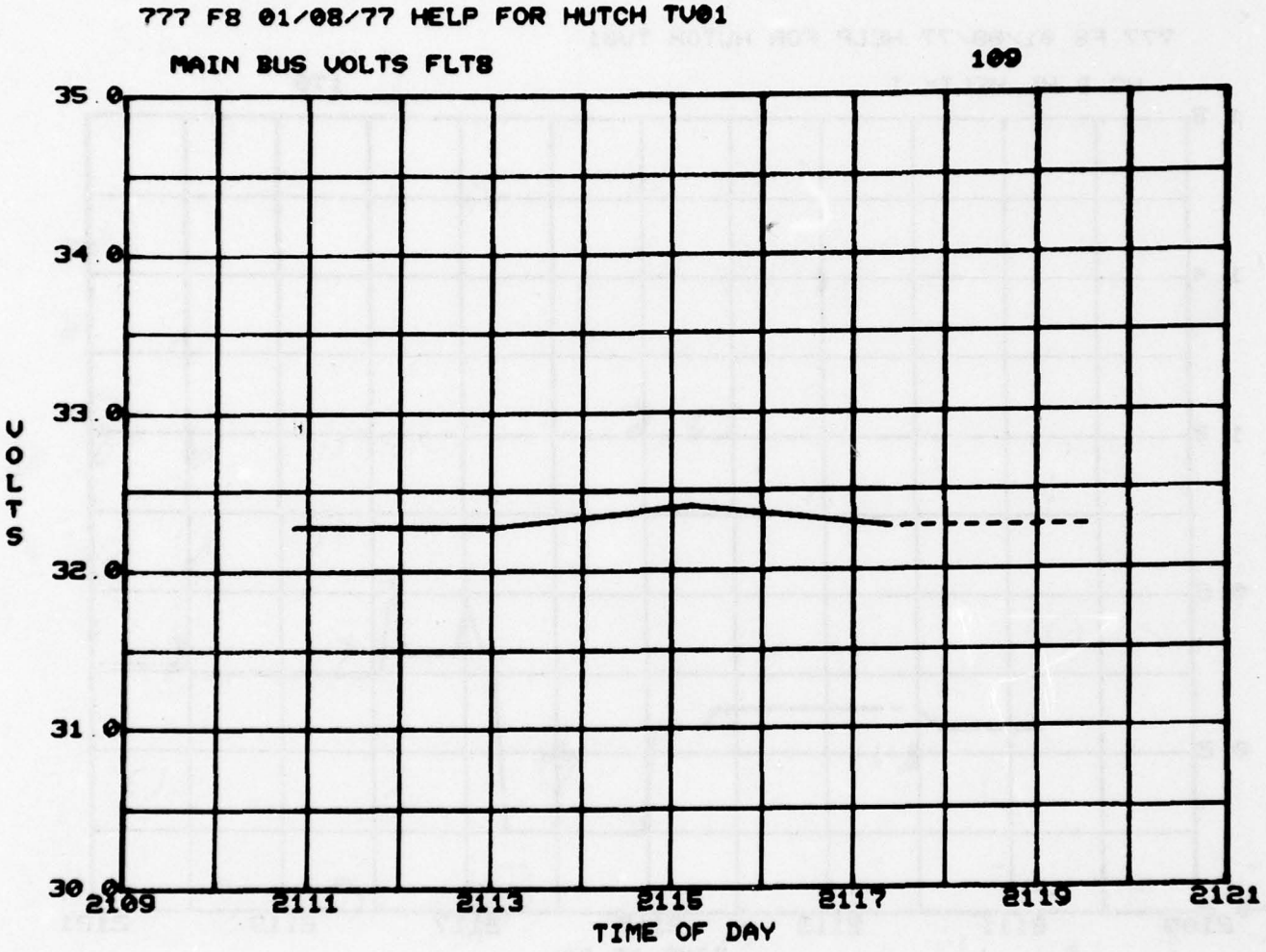

777 F8 12/23/76 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1050
1052
1054
1056
1058
1100
1102
TIME OF DAY

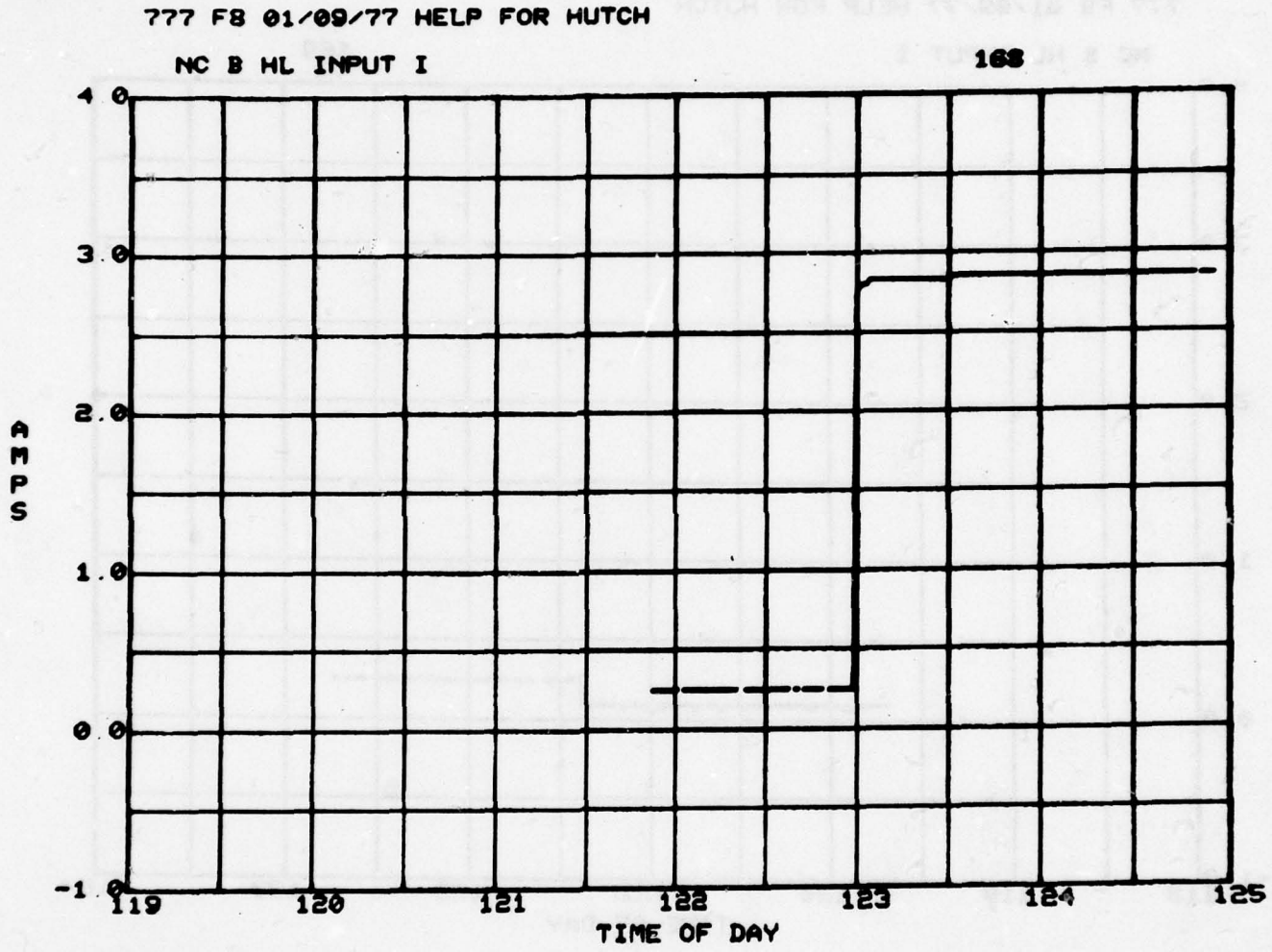

777 FB 01/08/77 HELP FOR HUTCH TV01
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
2111
2112
2113
2114
2115
2116
2117
TIME OF DAY

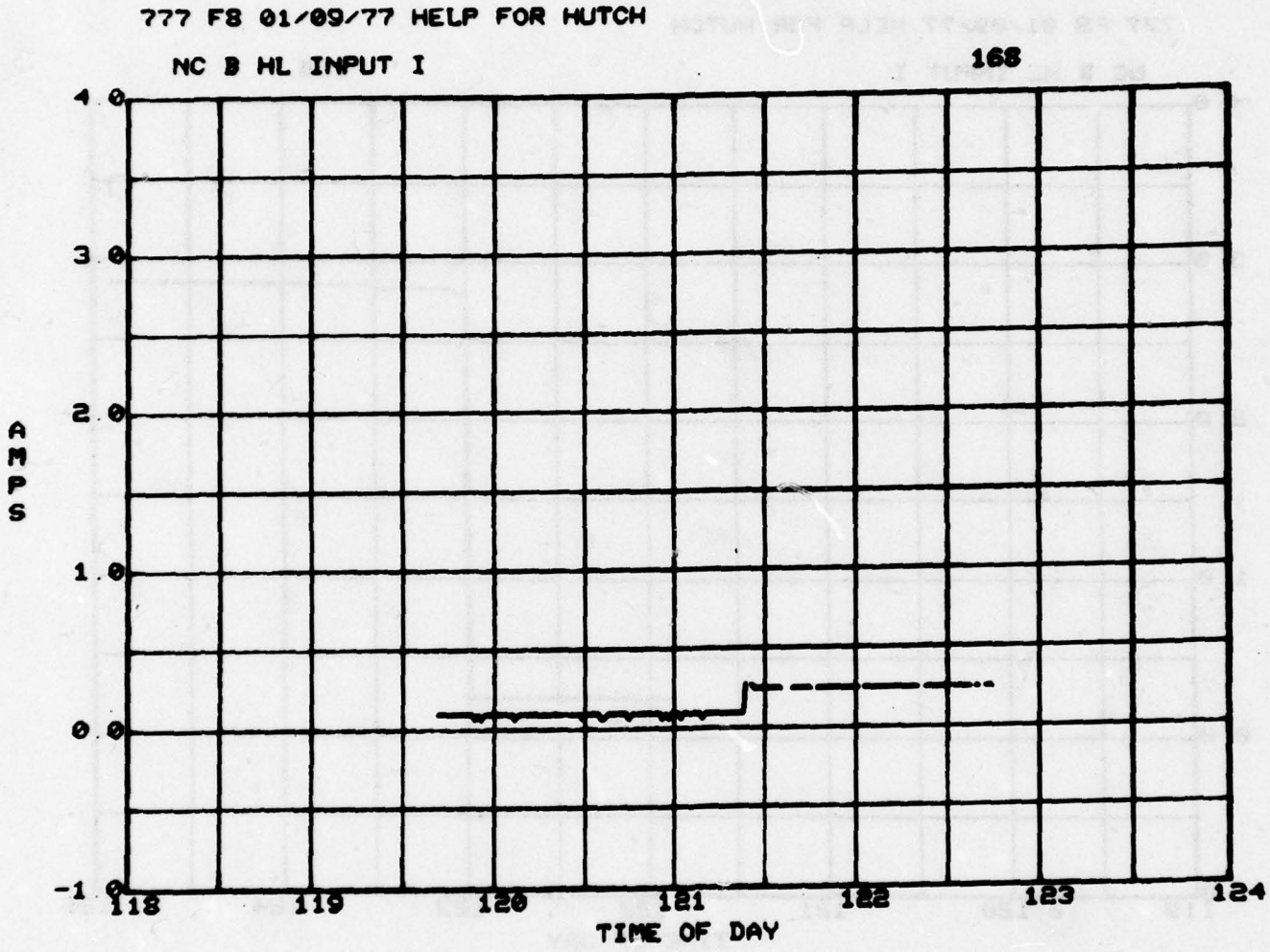

777 F8 01/08/77 HELP FOR HUTCH TV01
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
2113
2114
2115
2116
2117
2118
2119
TIME OF DAY

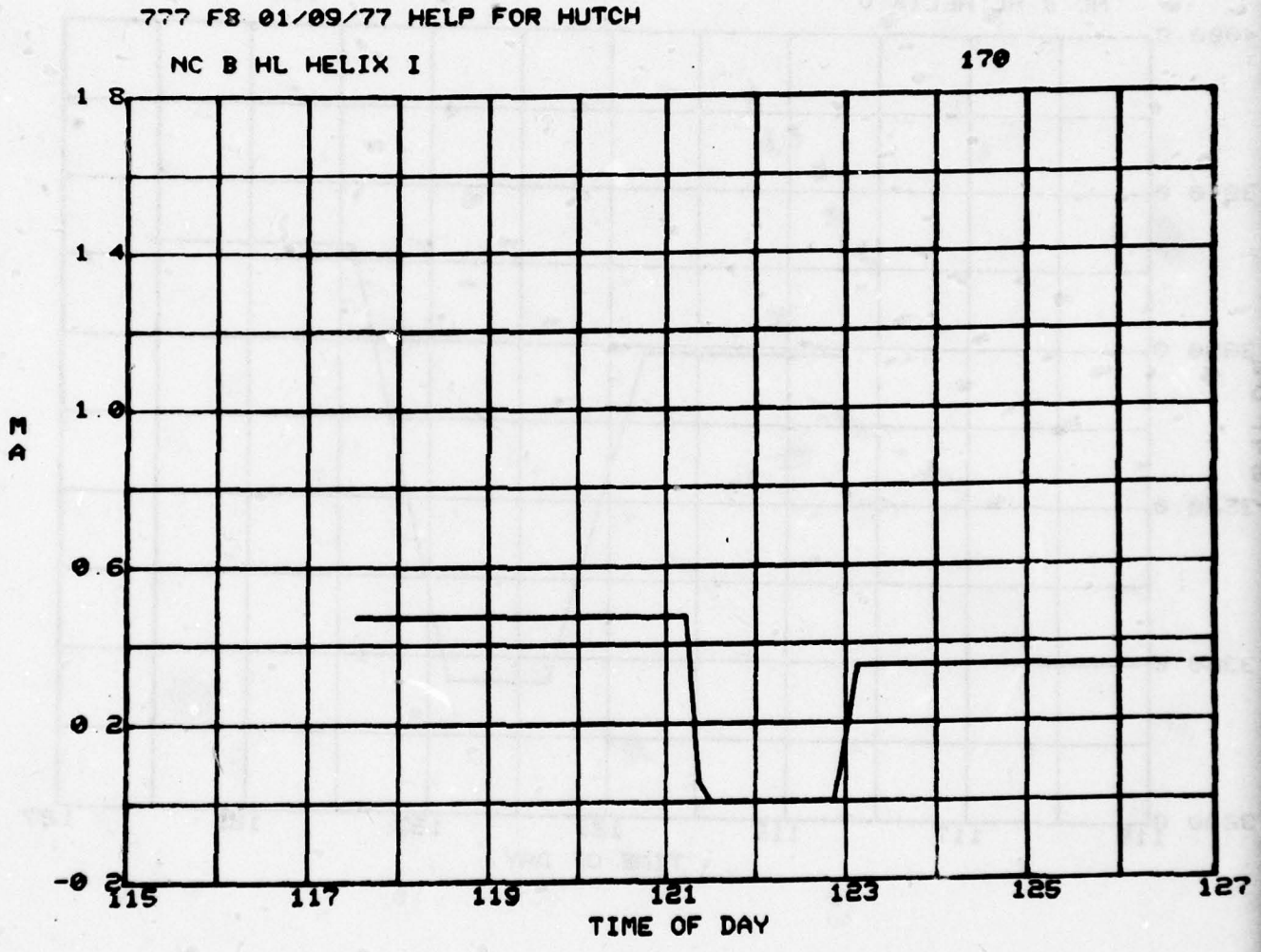

777 F8 01/08/77 HELP FOR HUTCH TV01
NC B HL HELIX V
169
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
2109
2111
2113
2115
2117
2119
2121
TIME OF DAY

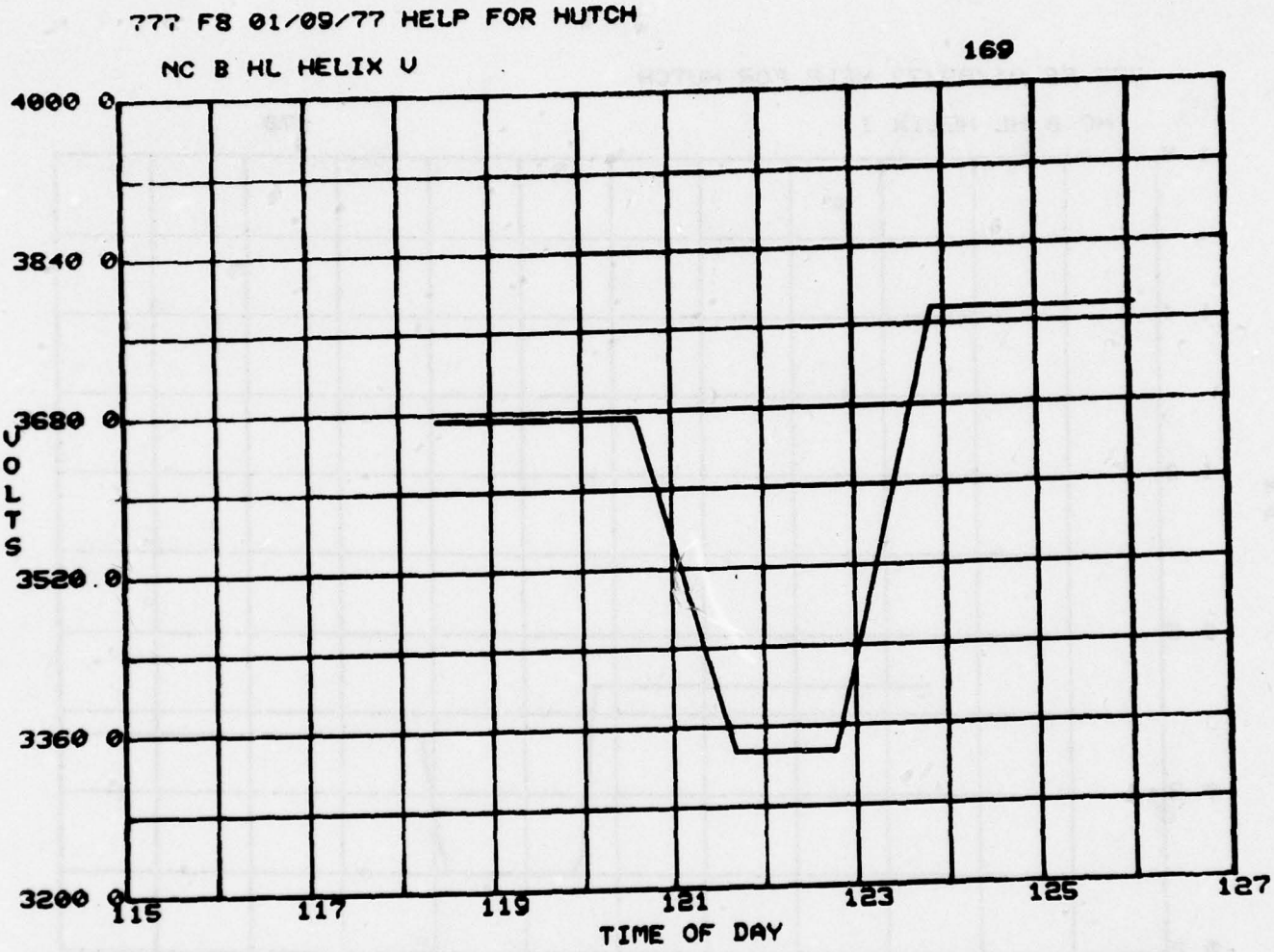

777 F8 01/08/77 HELP FOR HUTCH TV01
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
2109
2111
2113
2115
2117
2119
2121
TIME OF DAY

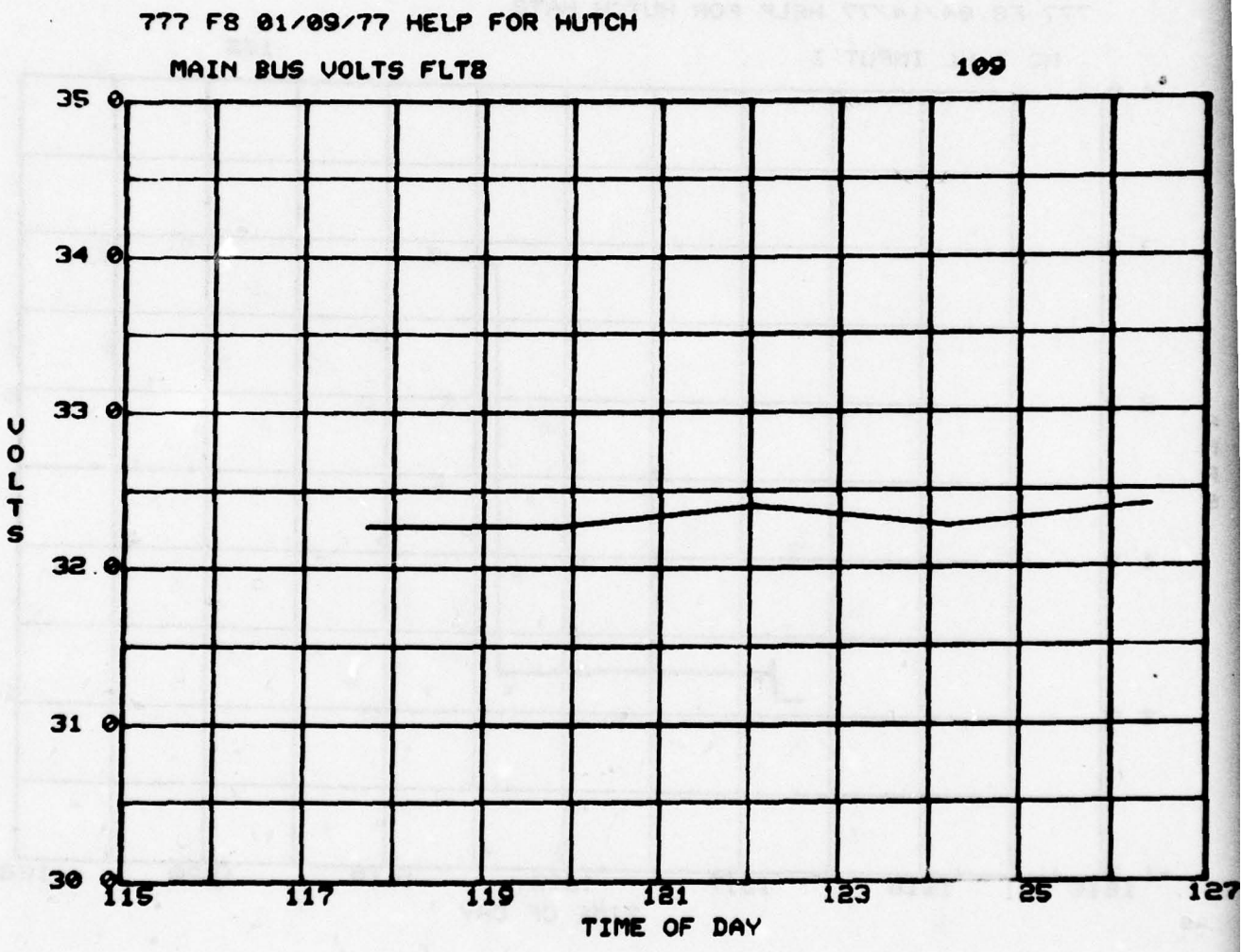

777 F8 01/08/77 HELP FOR HUTCH TV01
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
2109
2111
2113
2115
2117
2119
2121
TIME OF DAY

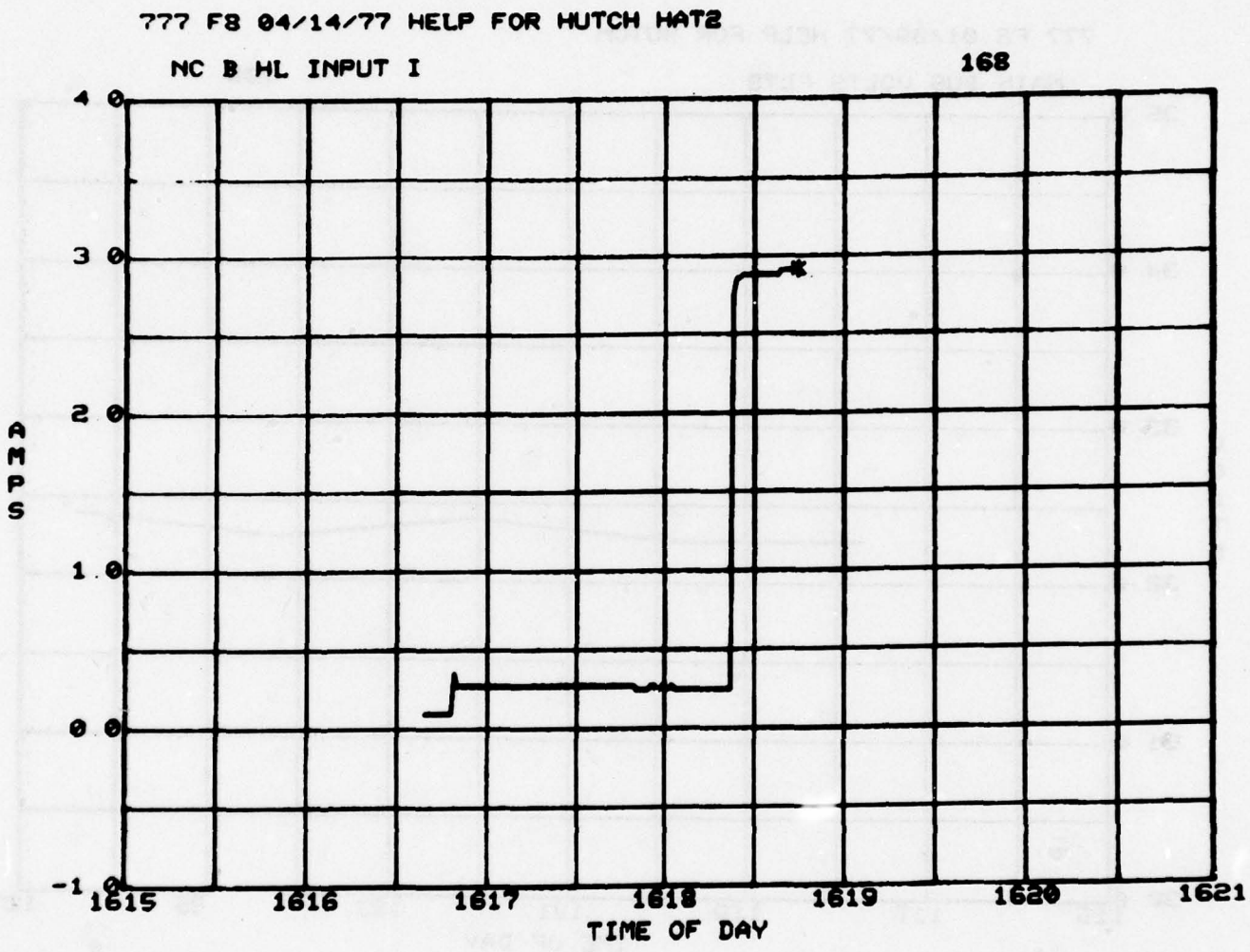

777 F8 01/09/77 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
119
120
121
122
123
124
125
TIME OF DAY

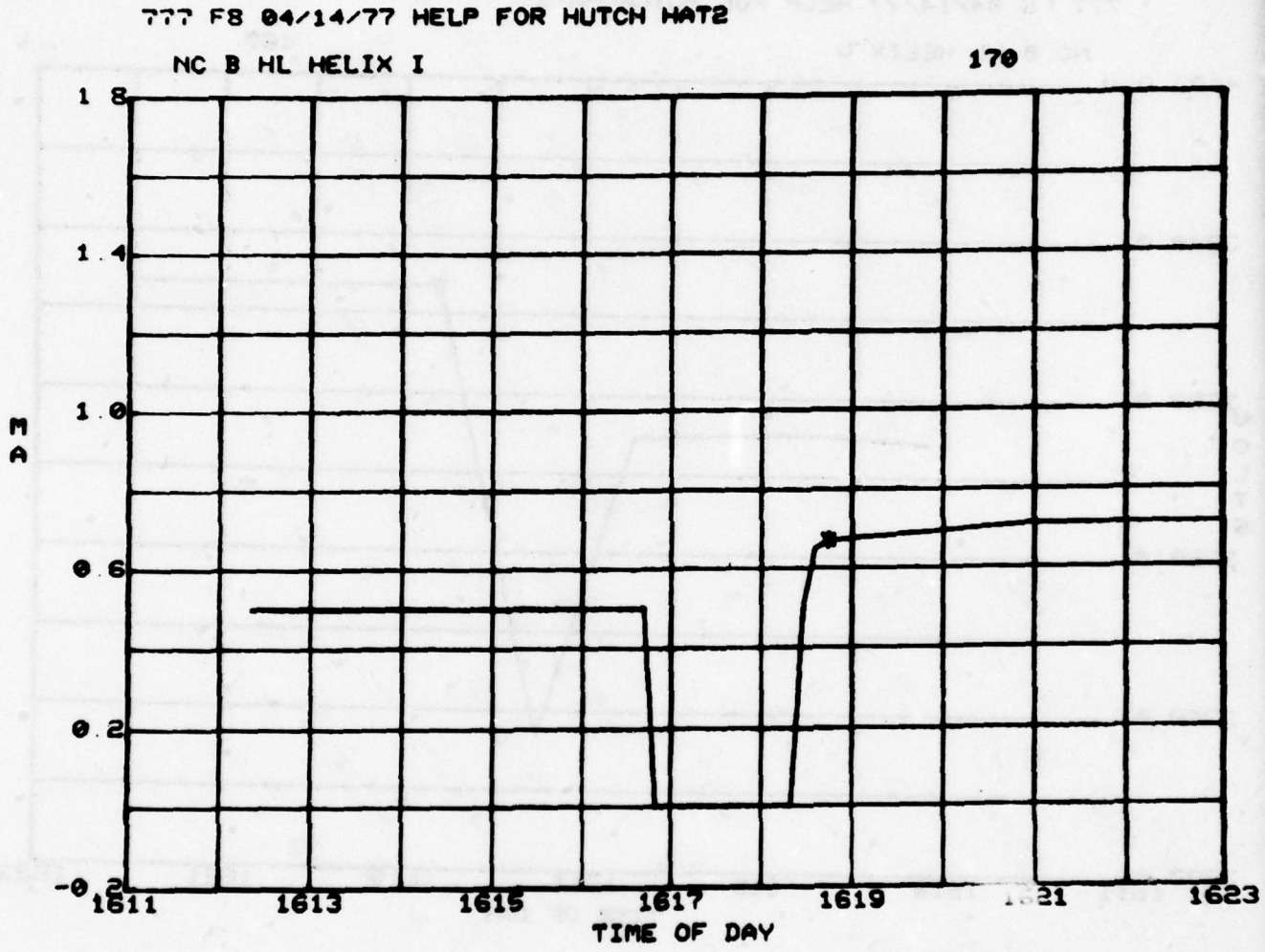

777 F8 01/09/77 HELP FOR HUTCH
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
118
119
120
121
122
123
124
TIME OF DAY

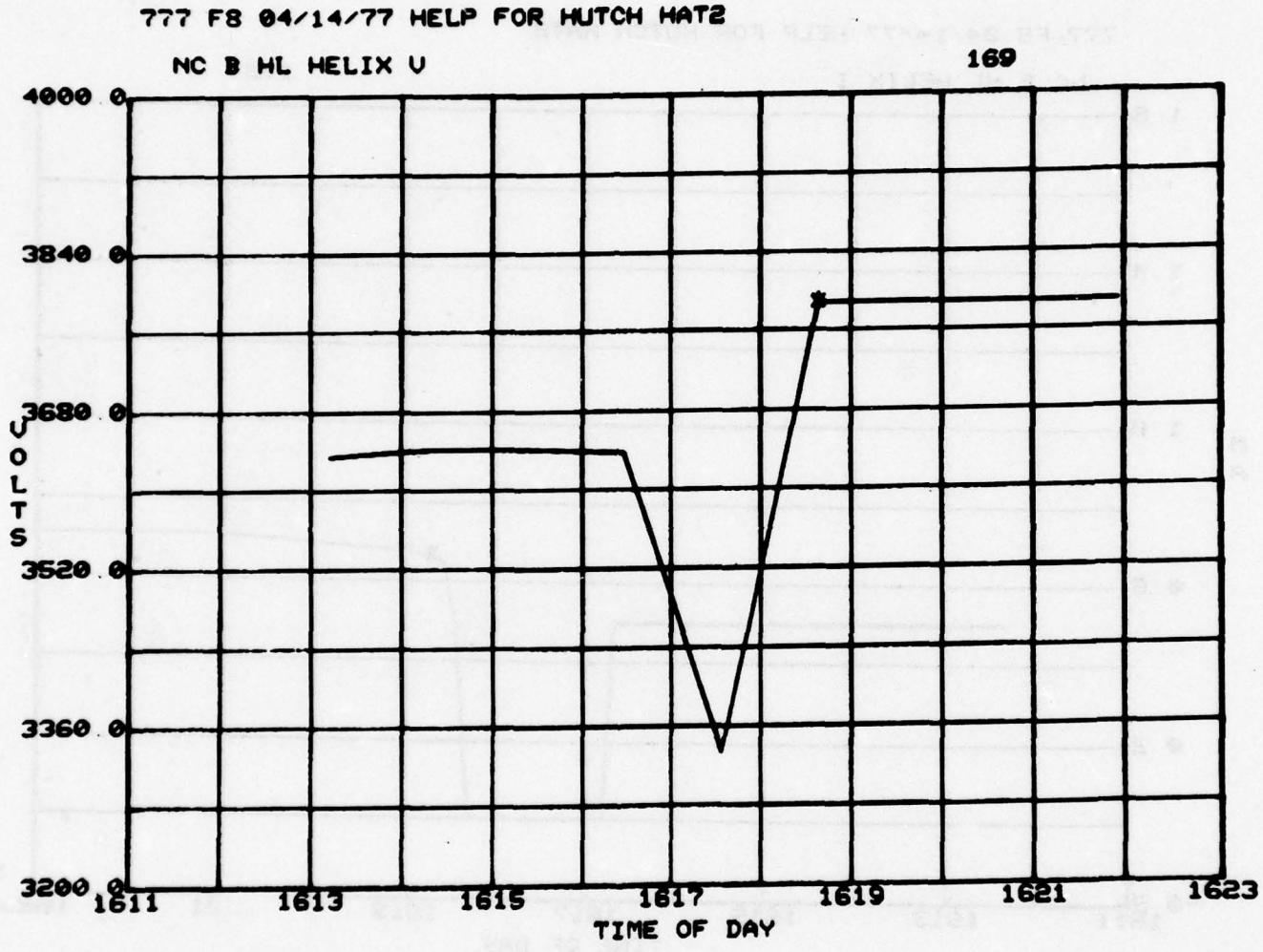

777 FS 01/09/77 HELP FOR HUTCH
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
115
117
119
121
123
125
127
TIME OF DAY

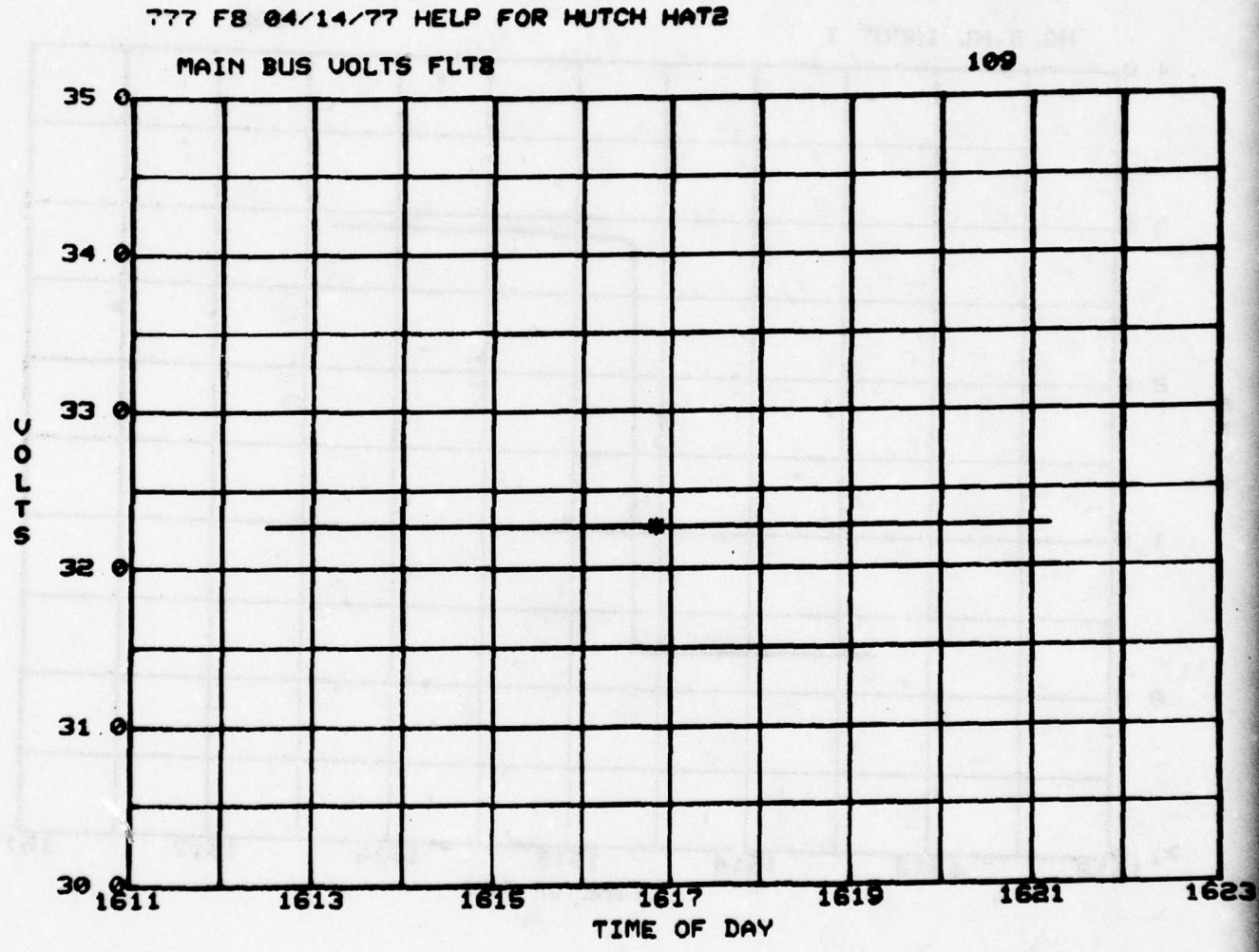

777 F8 01/09/77 HELP FOR HUTCH
NC B HL HELIX V
169
4000 0
3840 0
3680 0
3520 0
3360 0
3200 0
VOLTS
115
117
119
121
123
125
127
TIME OF DAY

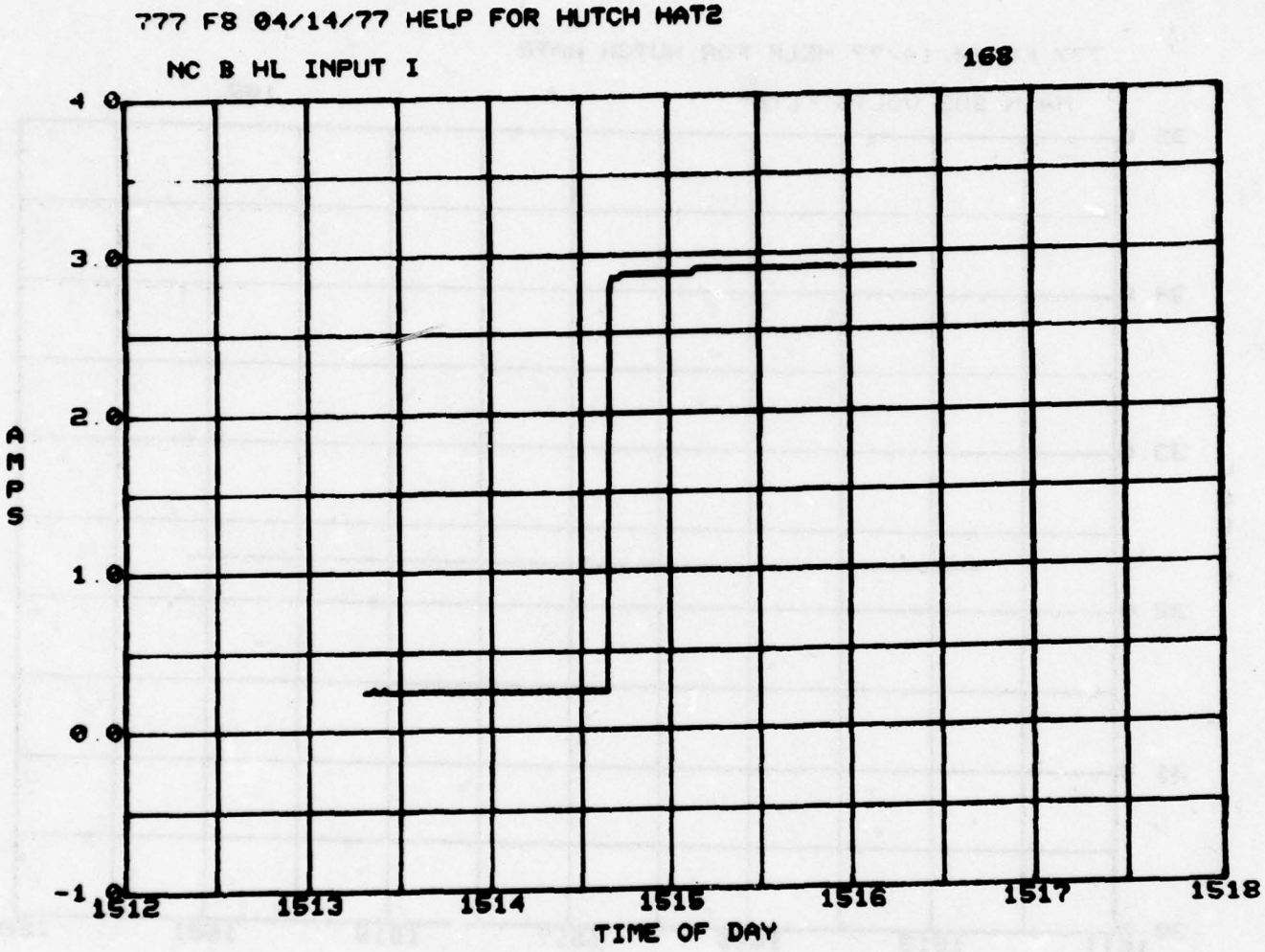

777 F8 01/09/77 HELP FOR HUTCH
MAIN BUS VOLTS FLT8
109
35 0
34 0
33 0
32 0
31 0
30 0
VOLTS
115
117
119
121
123
25
127
TIME OF DAY

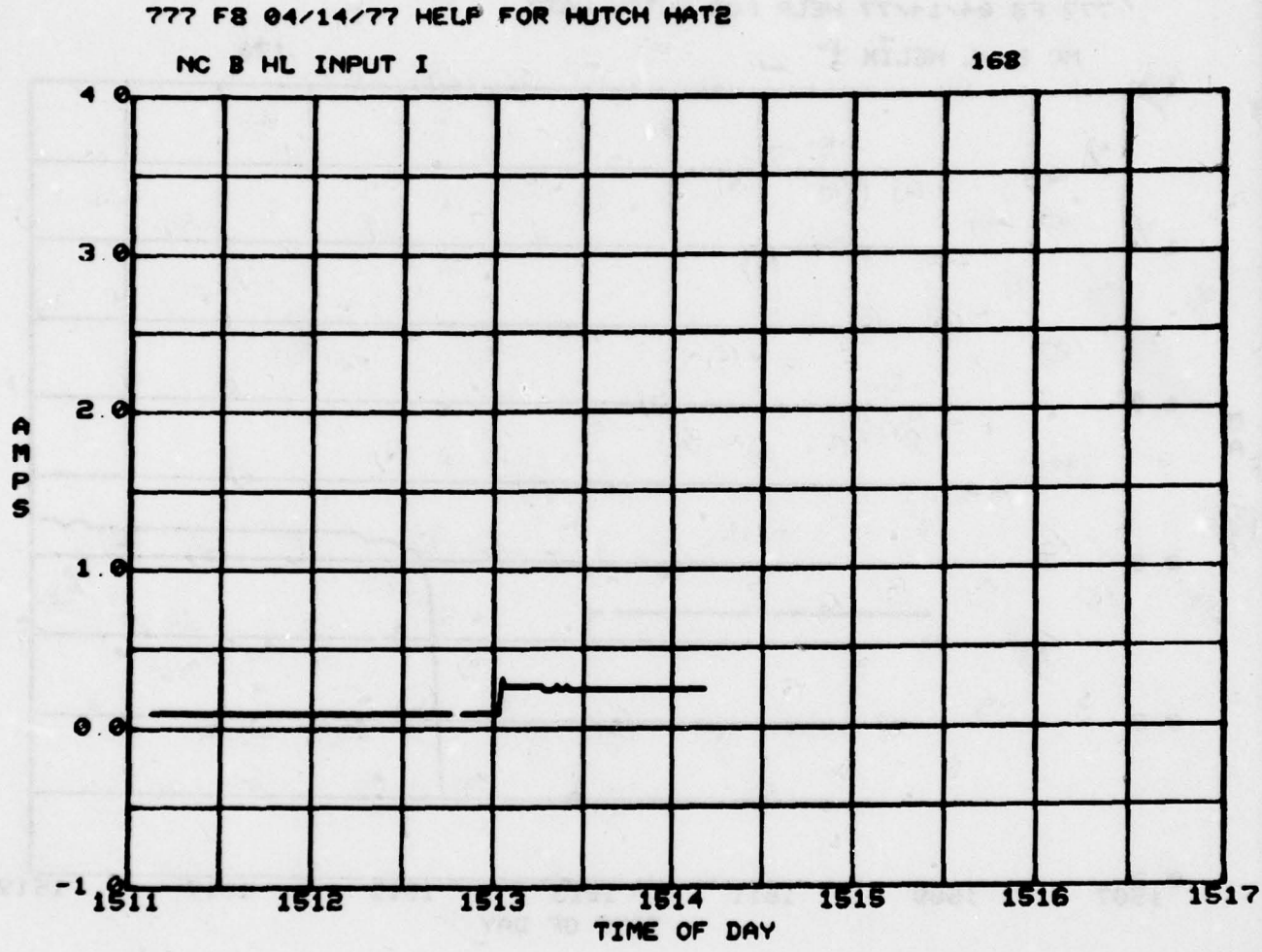

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL INPUT I
168
4 0
3 0
2 0
1 0
0 0
-1 0
AMPS
1615
1616
1617
1618
1619
1620
1621
TIME OF DAY

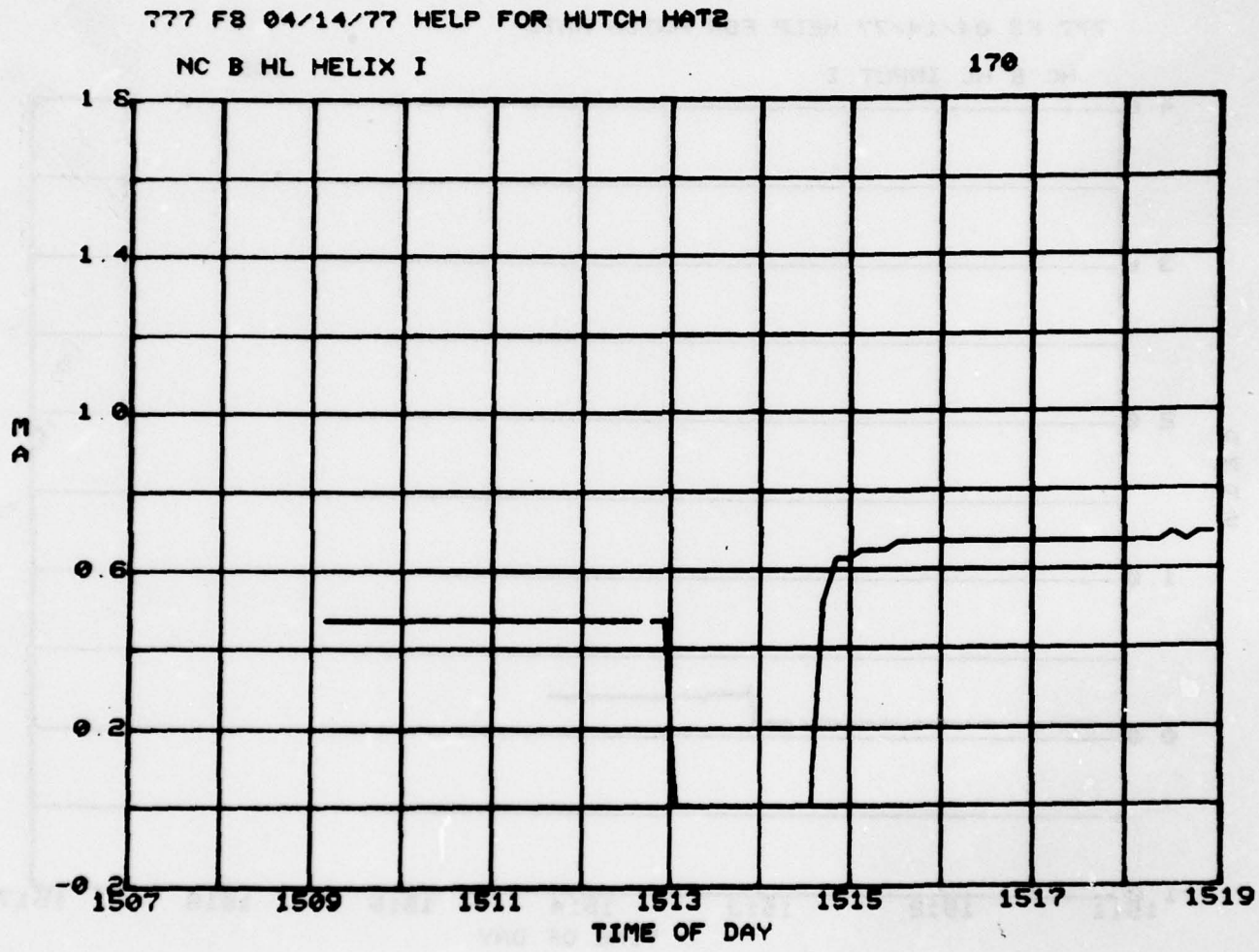

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1611
1613
1615
1617
1619
1621
1623
TIME OF DAY

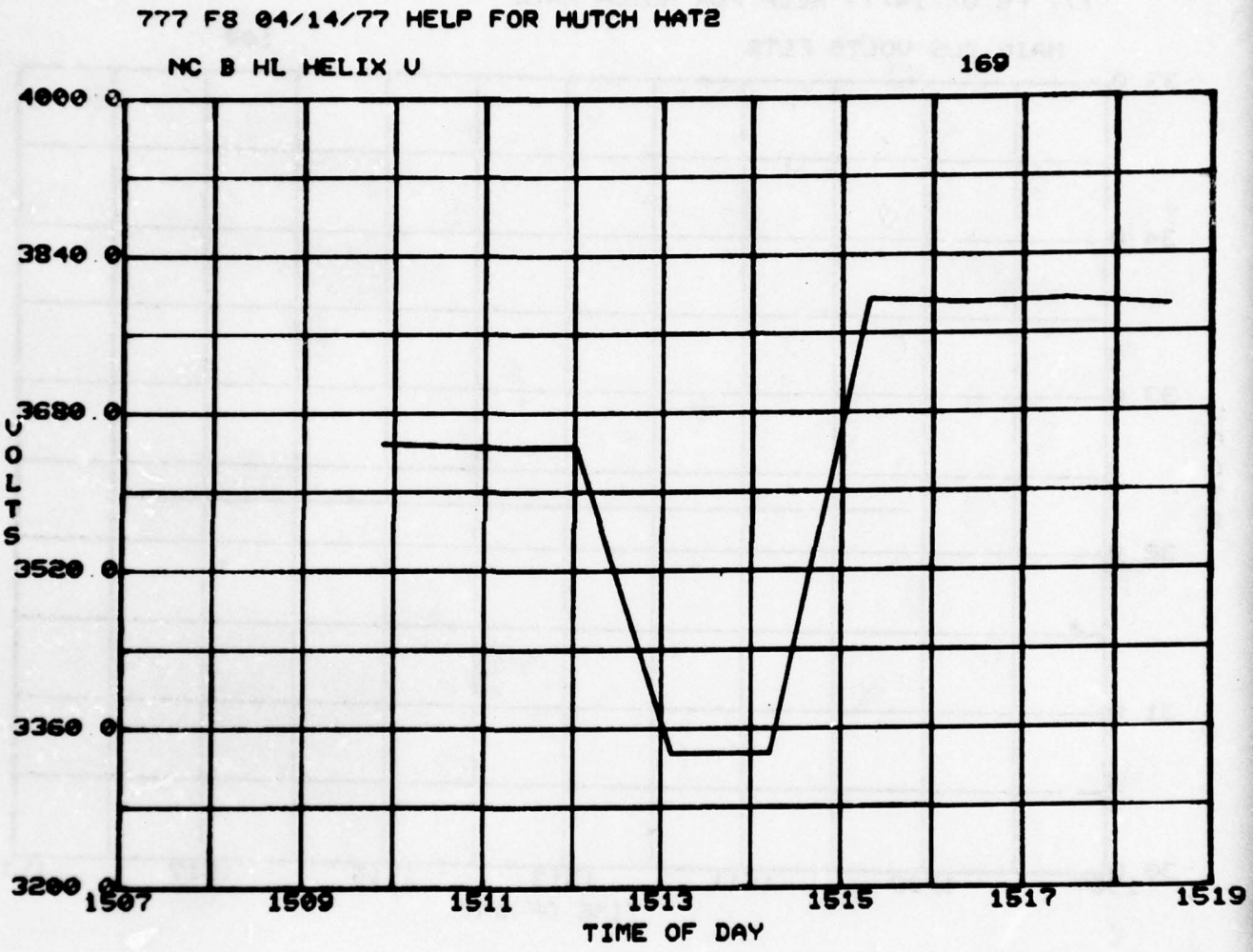

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL HELIX V
169
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1611
1613
1615
1617
1619
1621
1623
TIME OF DAY

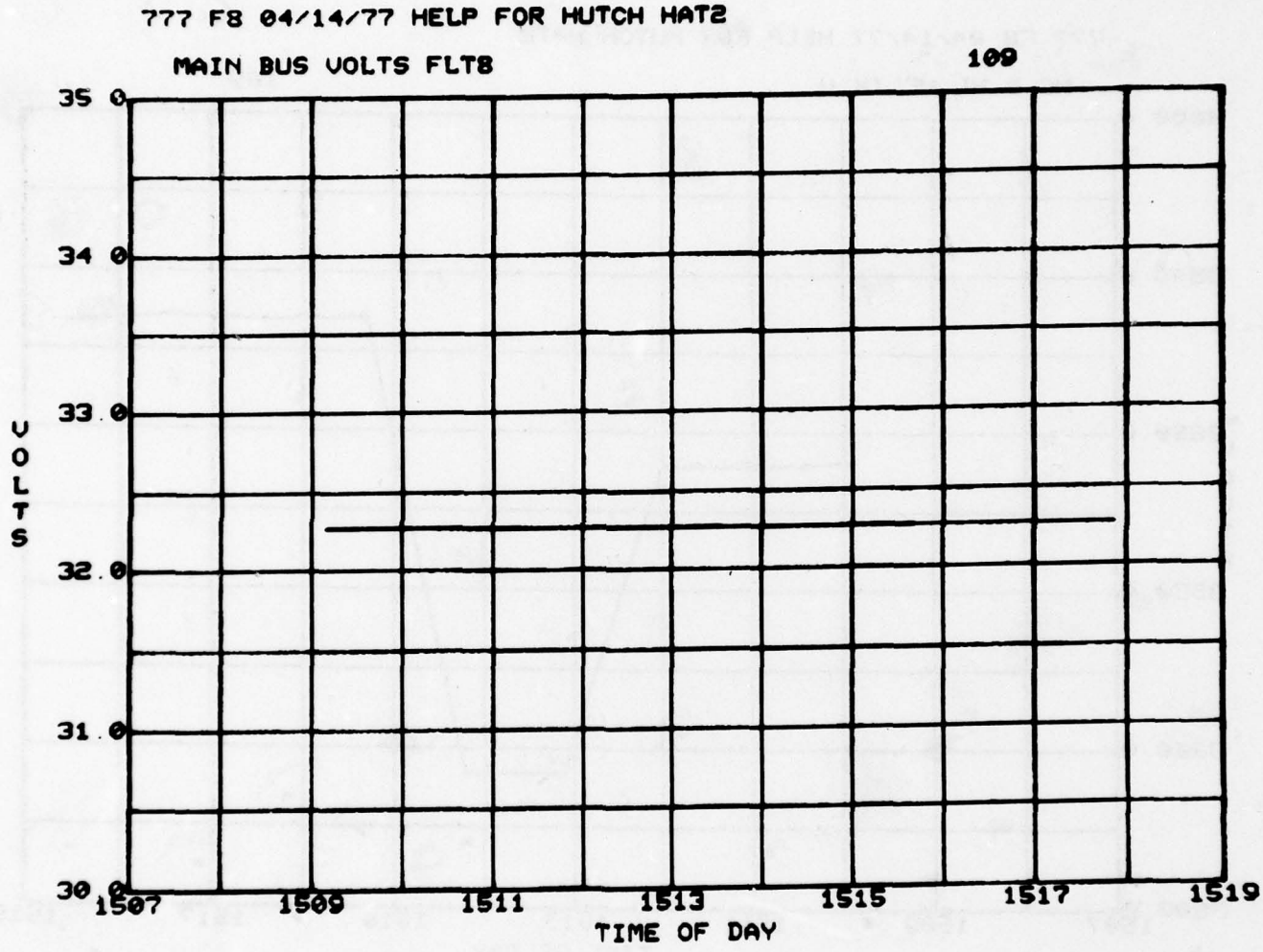

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1611
1613
1615
1617
1619
1621
1623
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1512
1513
1514
1515
1516
1517
1518
TIME OF DAY


777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL INPUT I
168
4.0
3.0
2.0
1.0
0.0
-1.0
AMPS
1511
1512
1513
1514
1515
1516
1517
TIME OF DAY

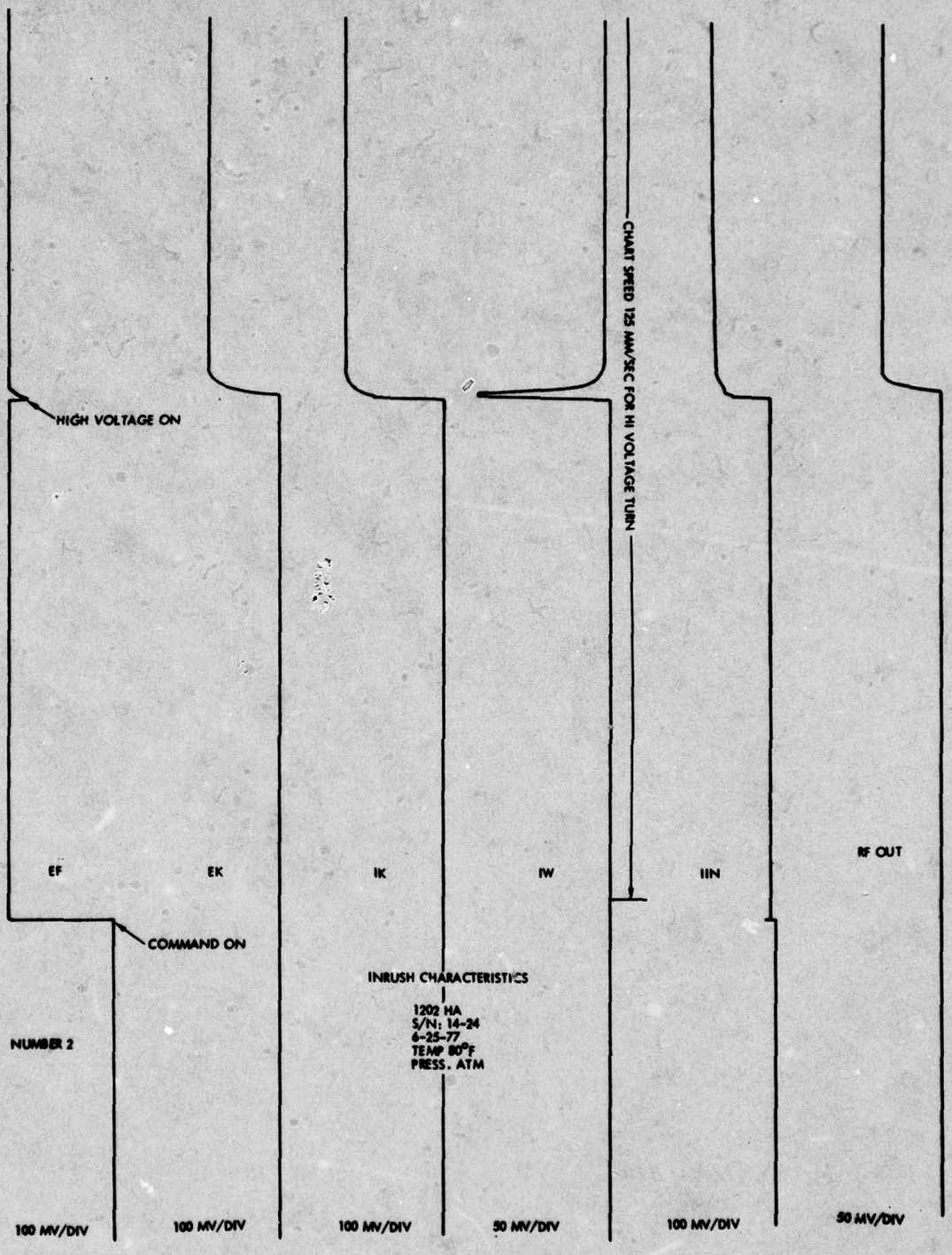

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL HELIX I
170
1.8
1.4
1.0
0.6
0.2
-0.2
MA
1507
1509
1511
1513
1515
1517
1519
TIME OF DAY

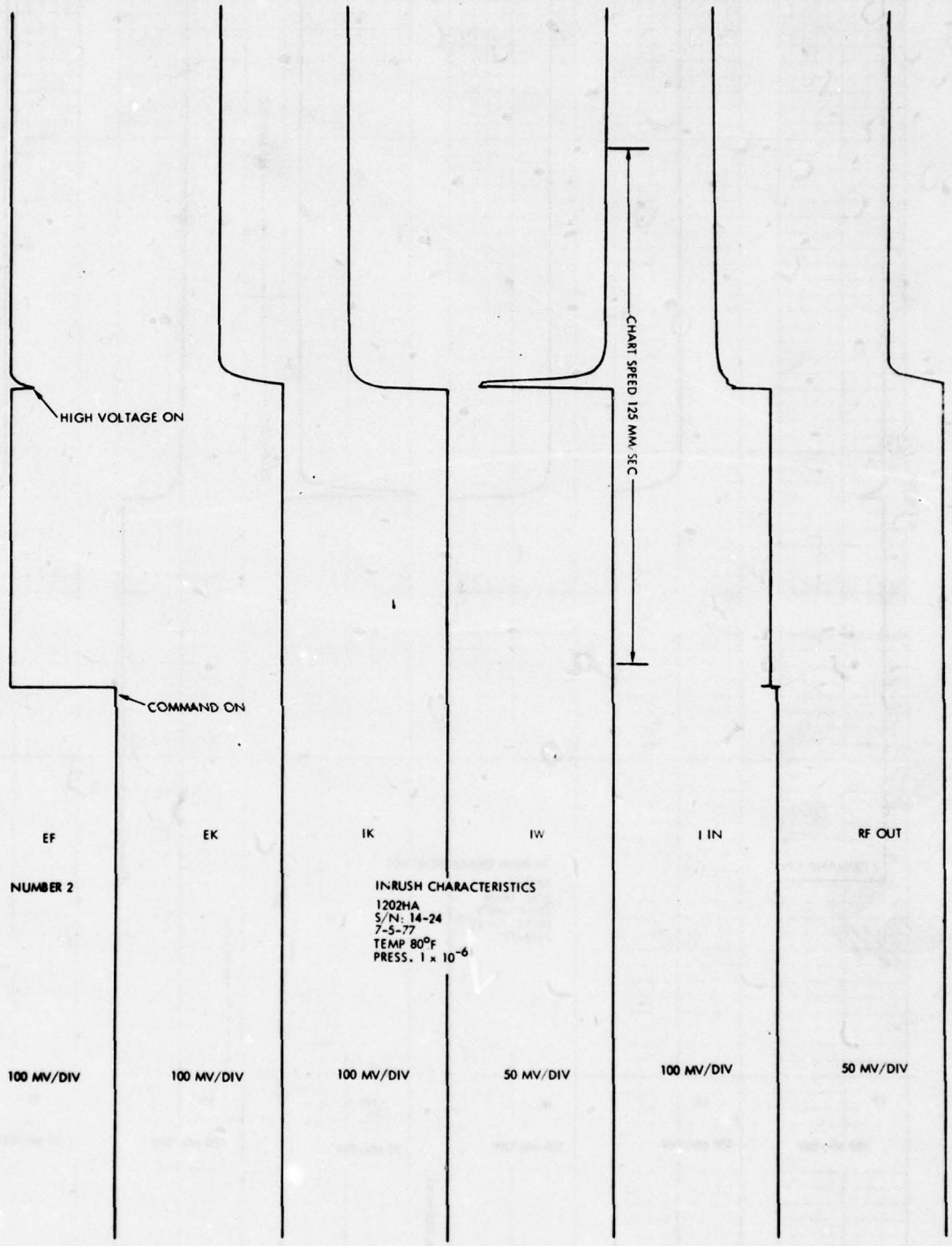

777 F8 04/14/77 HELP FOR HUTCH HAT2
NC B HL HELIX V
169
4000.0
3840.0
3680.0
3520.0
3360.0
3200.0
VOLTS
1507
1509
1511
1513
1515
1517
1519
TIME OF DAY

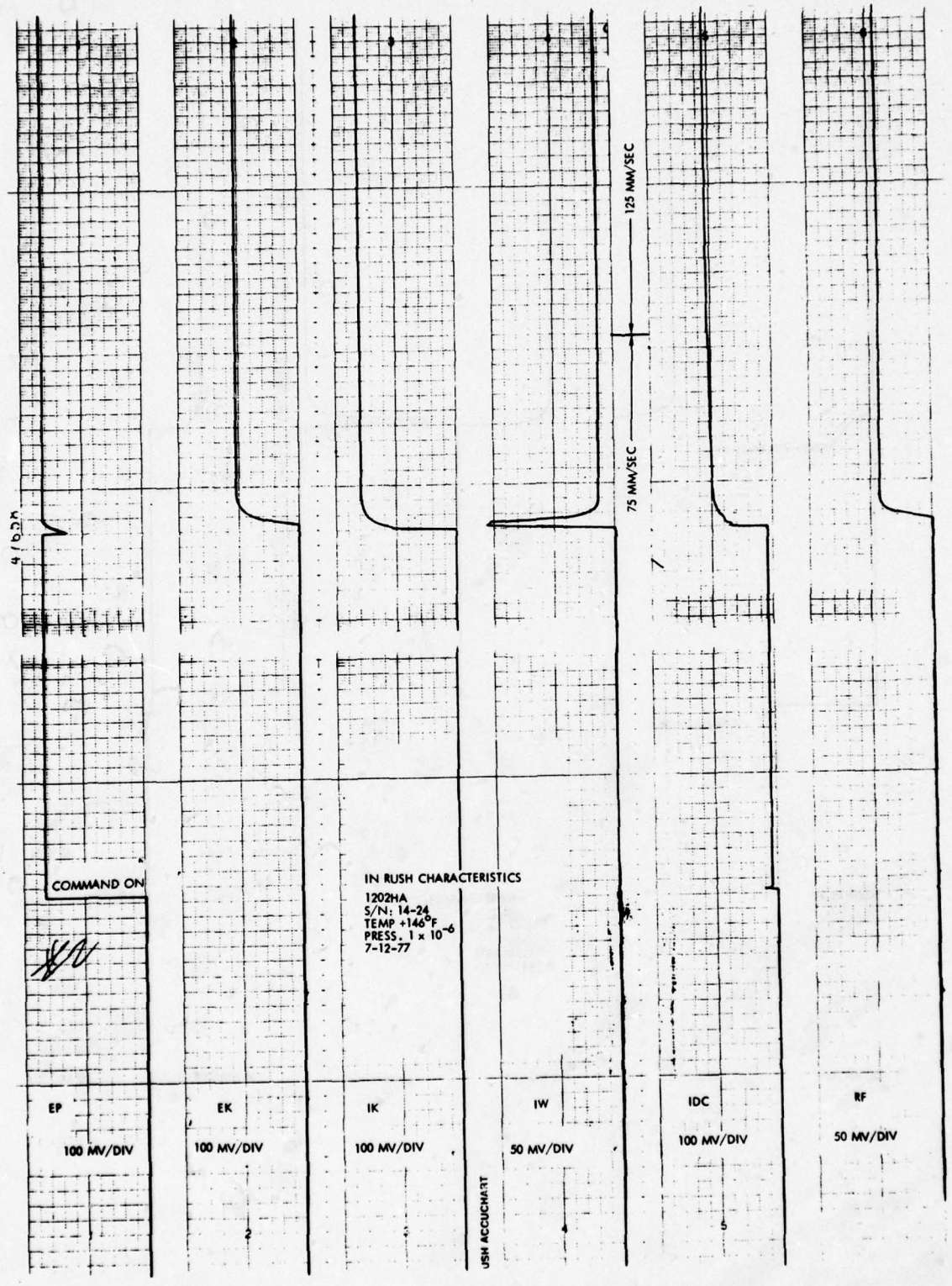

777 F8 04/14/77 HELP FOR HUTCH HAT2
MAIN BUS VOLTS FLT8
109
35.0
34.0
33.0
32.0
31.0
30.0
VOLTS
1507
1509
1511
1513
1515
1517
1519
TIME OF DAY

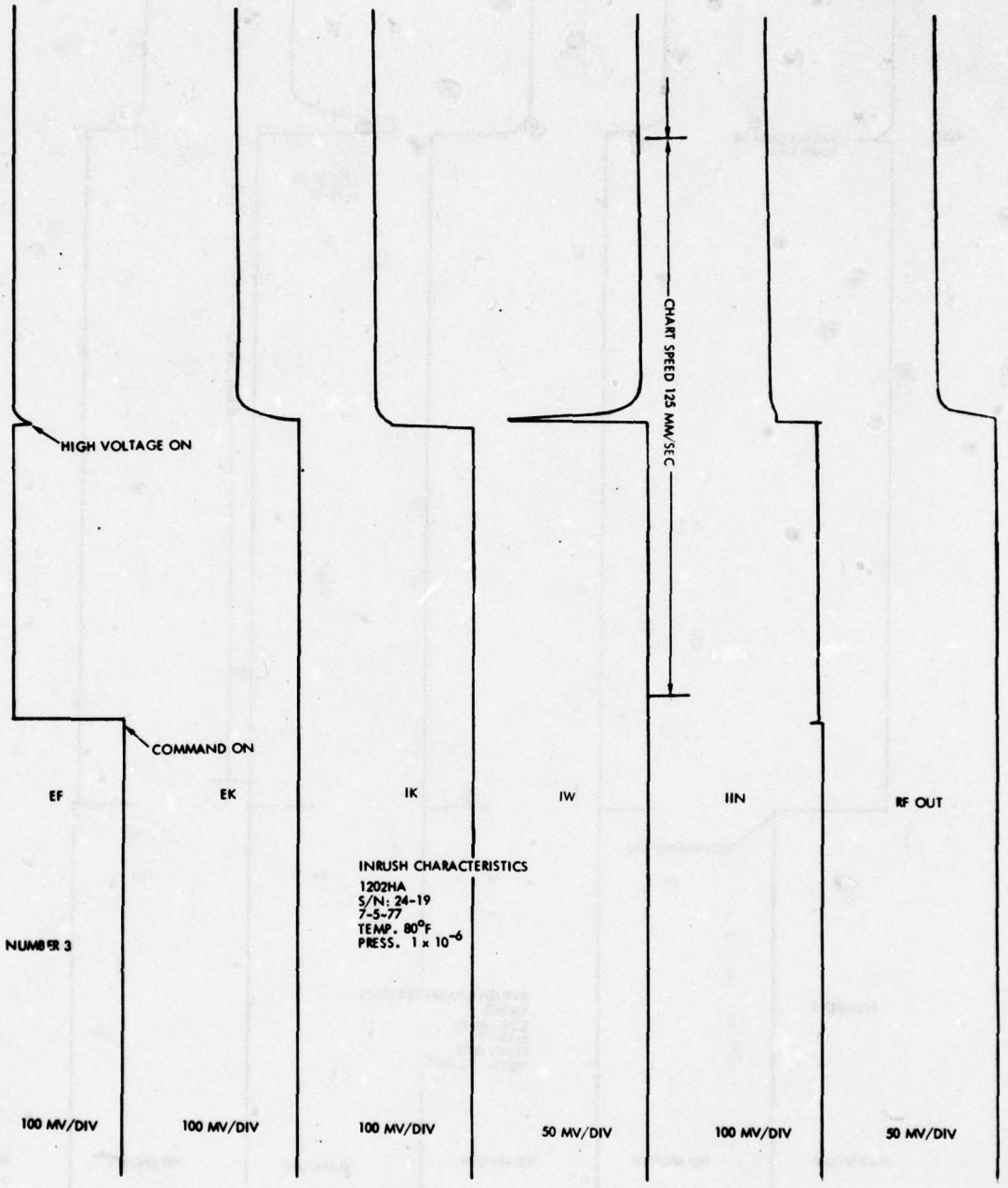
APPENDIX A-5

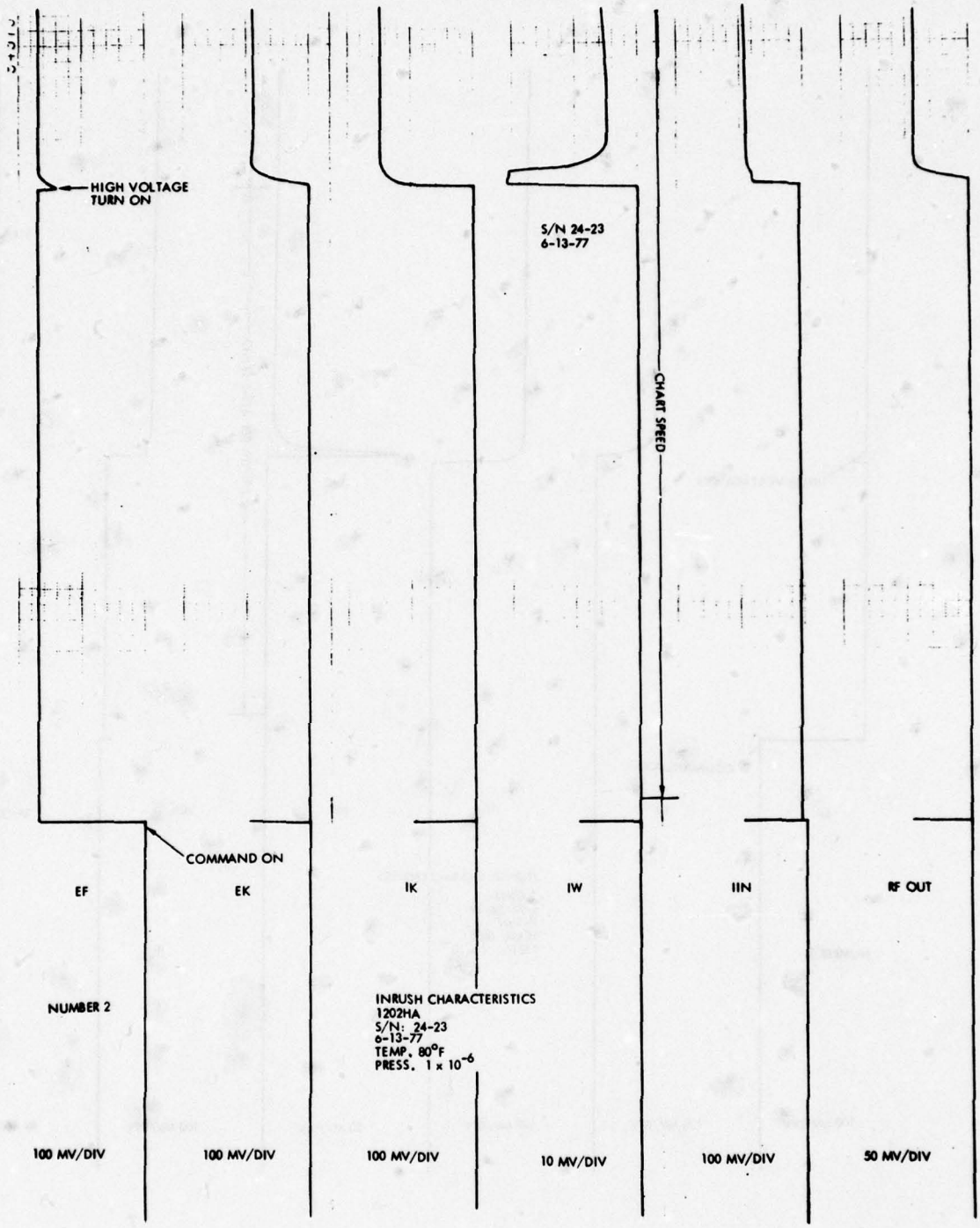
RECORDINGS OF SELECTED HLTWTA TURN ON EVENTS DURING EXPENDED TEMPERATURE CYCLING THERMAL VACUUM TESTING

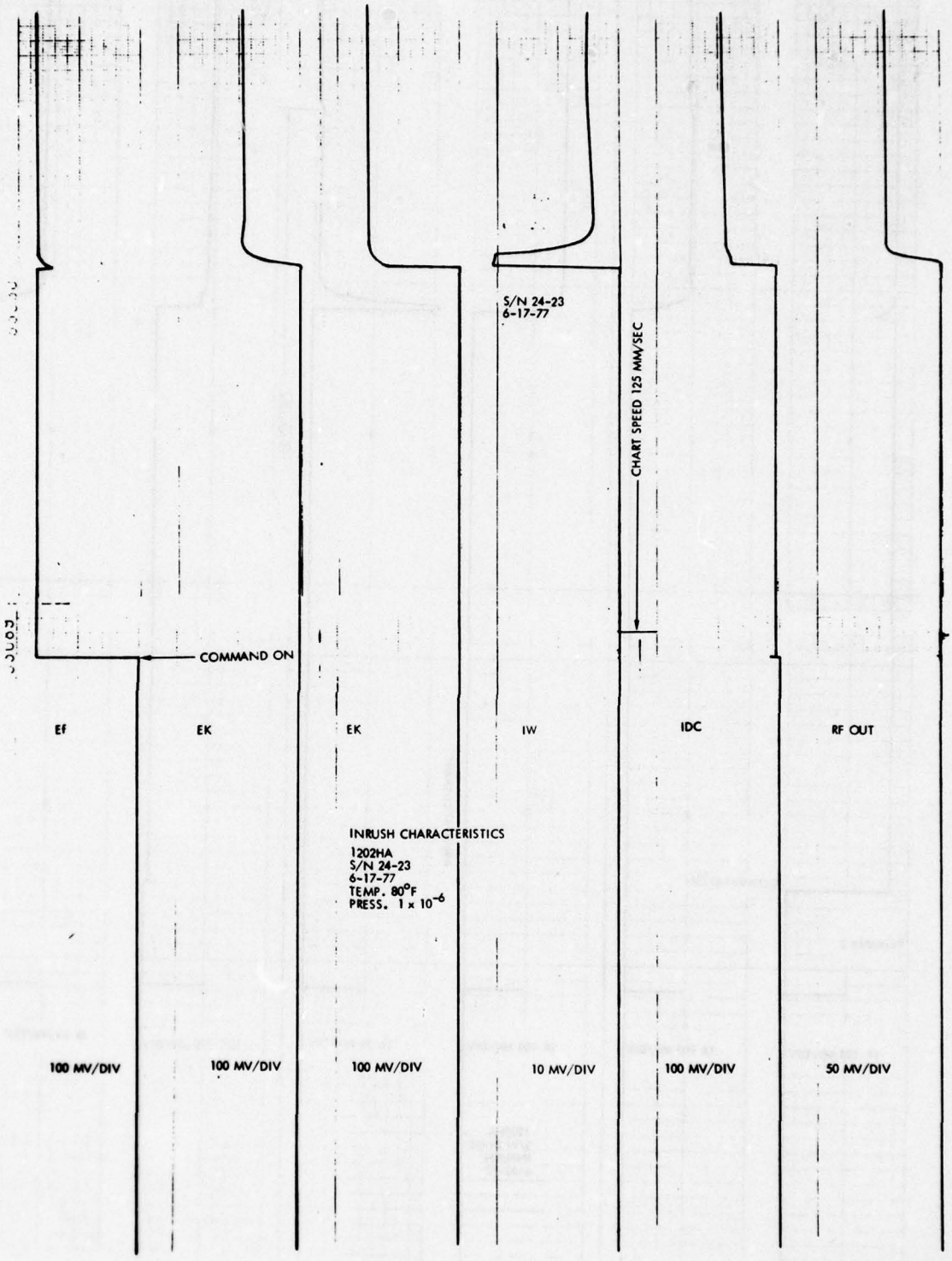

HIGH VOLTAGE ON
CHART SPEED 125 MM/SEC FOR HI VOLTAGE TURN
EF
EK
IK
IW
IIN
RF OUT
COMMAND ON
INRUSH CHARACTERISTICS
1202 HA
S/N: 14-24
6-25-77
TEMP 80°F
PRESS. ATM
NUMBER 2
100 MV/DIV
100 MV/DIV
100 MV/DIV
50 MV/DIV
100 MV/DIV
50 MV/DIV

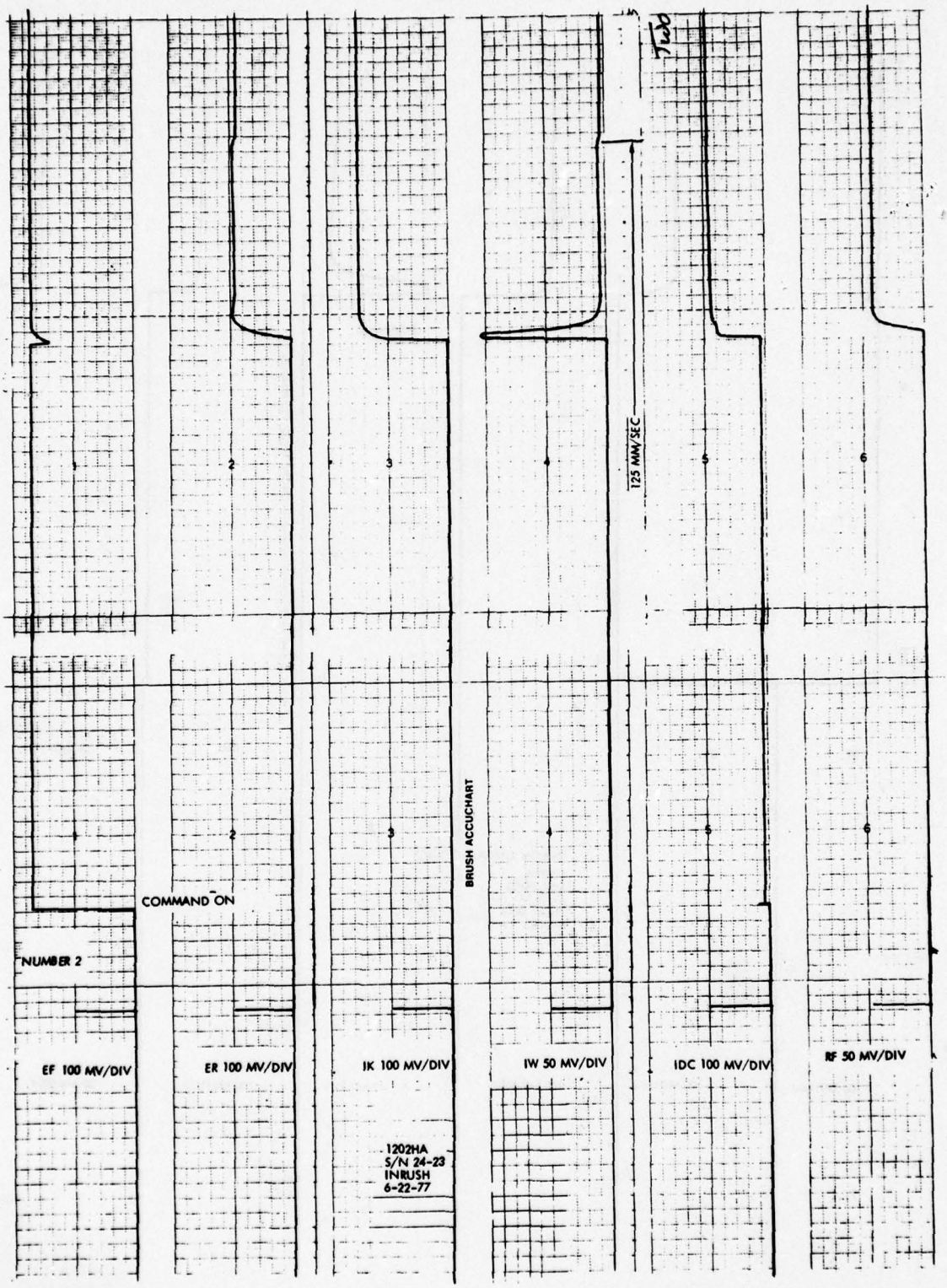

HIGH VOLTAGE ON
COMMAND ON
CHART SPEED 125 MM SEC
EF
EK
IK
IW
I IN
RF OUT
NUMBER 2
INRUSH CHARACTERISTICS
1202HA
S/N: 14-24
7-5-77
TEMP 80°F
PRESS. 1 x 10⁻⁶
100 MV/DIV
100 MV/DIV
100 MV/DIV
50 MV/DIV
100 MV/DIV
50 MV/DIV

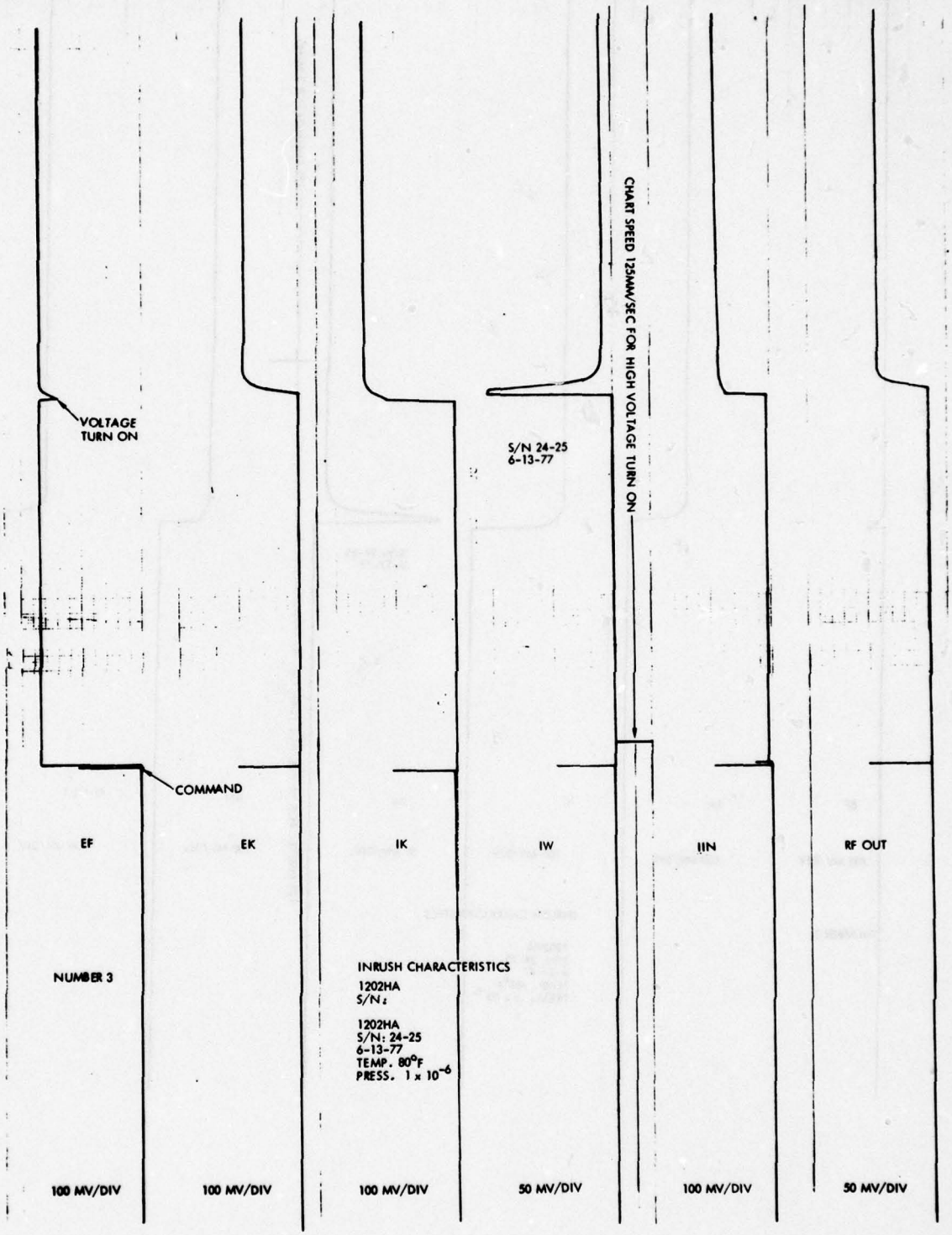

125 MM/SEC
75 MM/SEC
COMMAND ON
IN RUSH CHARACTERISTICS
1202HA
S/N: 14-24
TEMP +146°F
PRESS. 1 x 10⁻⁶
7-12-77
EP
100 MV/DIV
EK
100 MV/DIV
IK
100 MV/DIV
IW
50 MV/DIV
IDC
100 MV/DIV
RF
50 MV/DIV
USH ACCUCHART

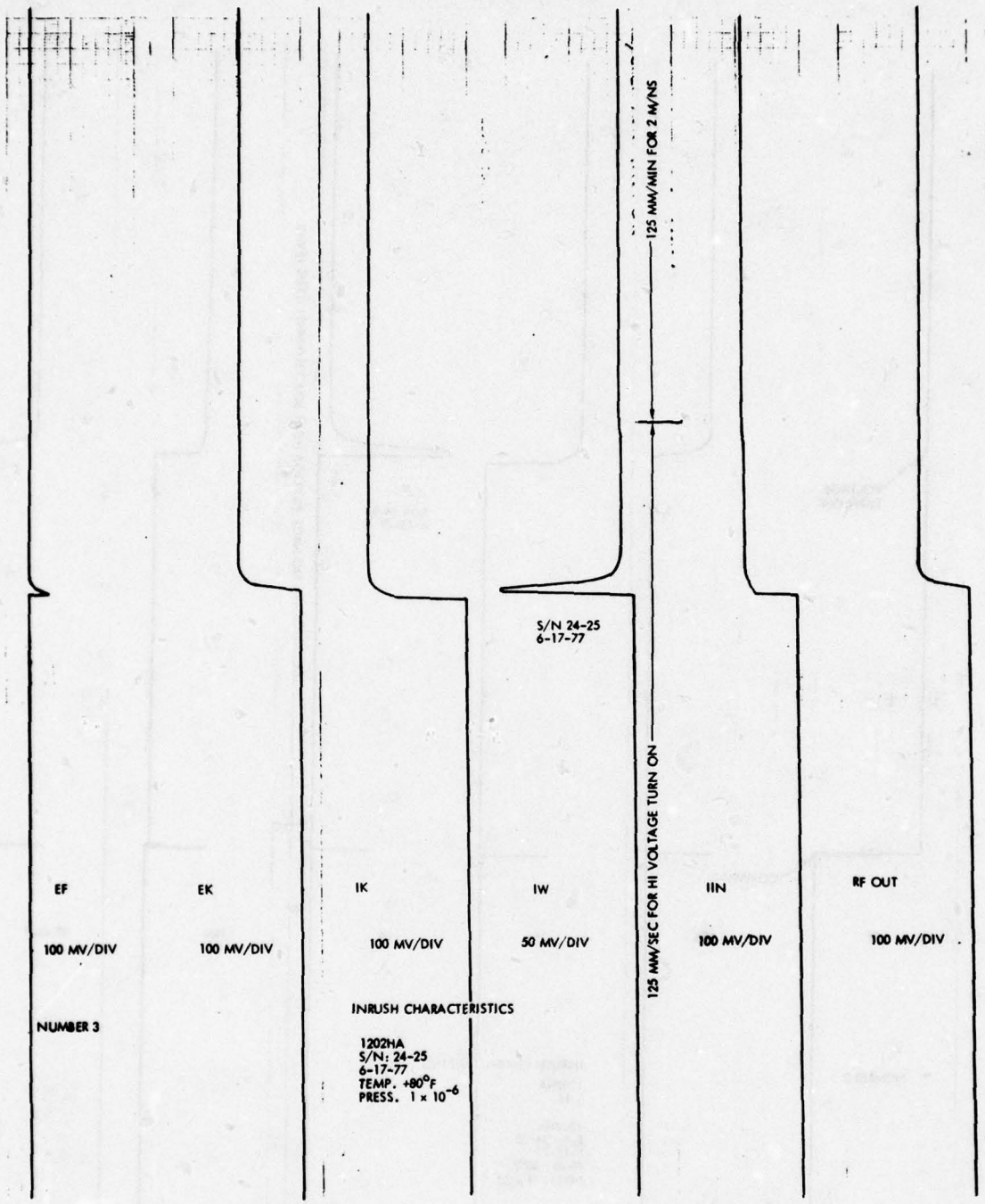

HIGH VOLTAGE ON
COMMAND ON
CHART SPEED 125 MM/SEC
EF
EK
IK
IW
IIN
RF OUT
INRUSH CHARACTERISTICS
1202HA
S/N: 24-19
7-5-77
TEMP. 80°F
PRESS. 1 x 10⁻⁶
NUMBER 3
100 MV/DIV
100 MV/DIV
100 MV/DIV
50 MV/DIV
100 MV/DIV
50 MV/DIV

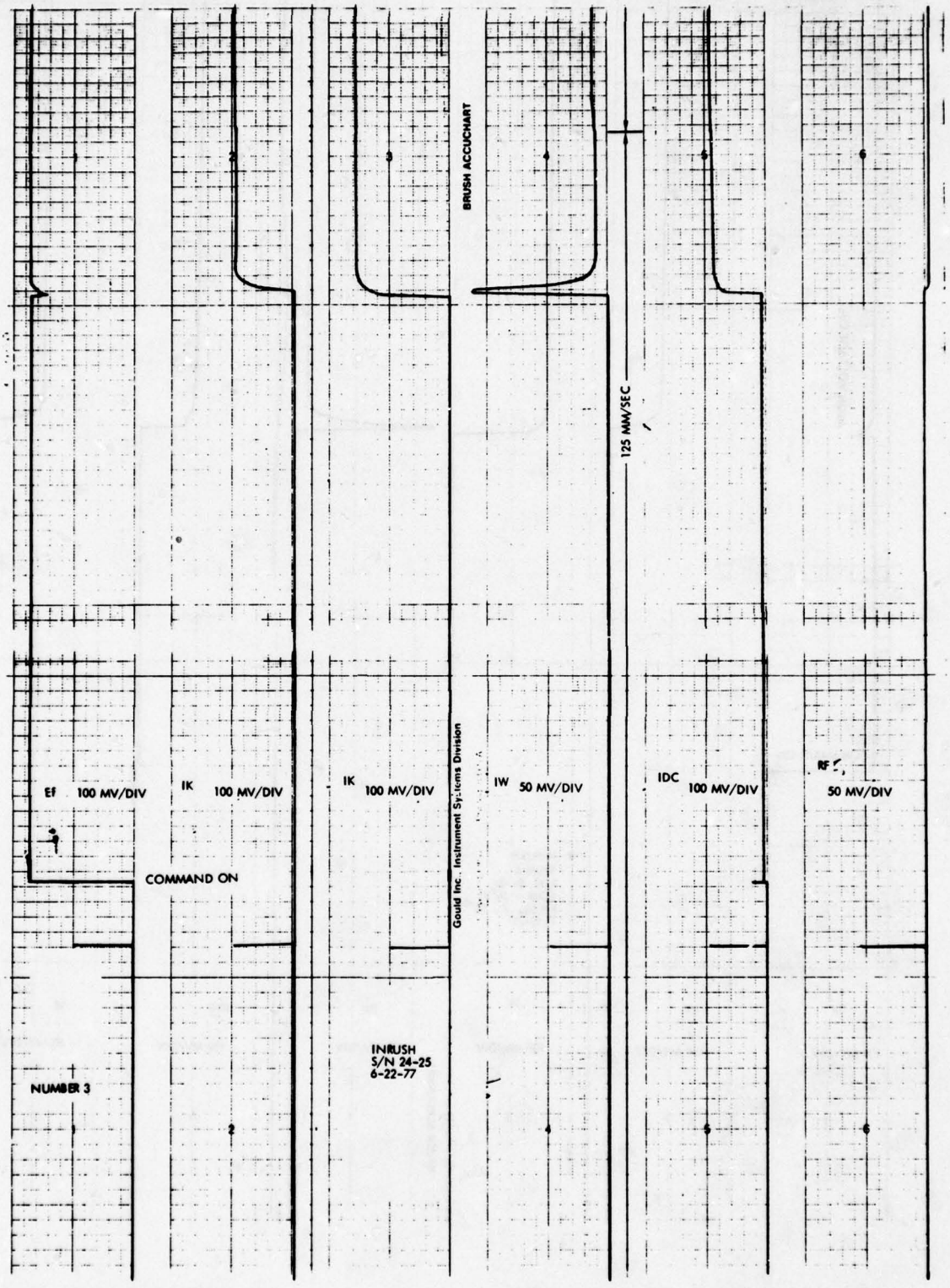

HIGH VOLTAGE
TURN ON
S/N 24-23
6-13-77
CHART SPEED
COMMAND ON
EF
EK
IK
IW
IIN
RF OUT
NUMBER 2
INRUSH CHARACTERISTICS
1202HA
S/N: 24-23
6-13-77
TEMP. 80°F
PRESS. 1 x 10⁻⁶
100 MV/DIV
100 MV/DIV
100 MV/DIV
10 MV/DIV
100 MV/DIV
50 MV/DIV

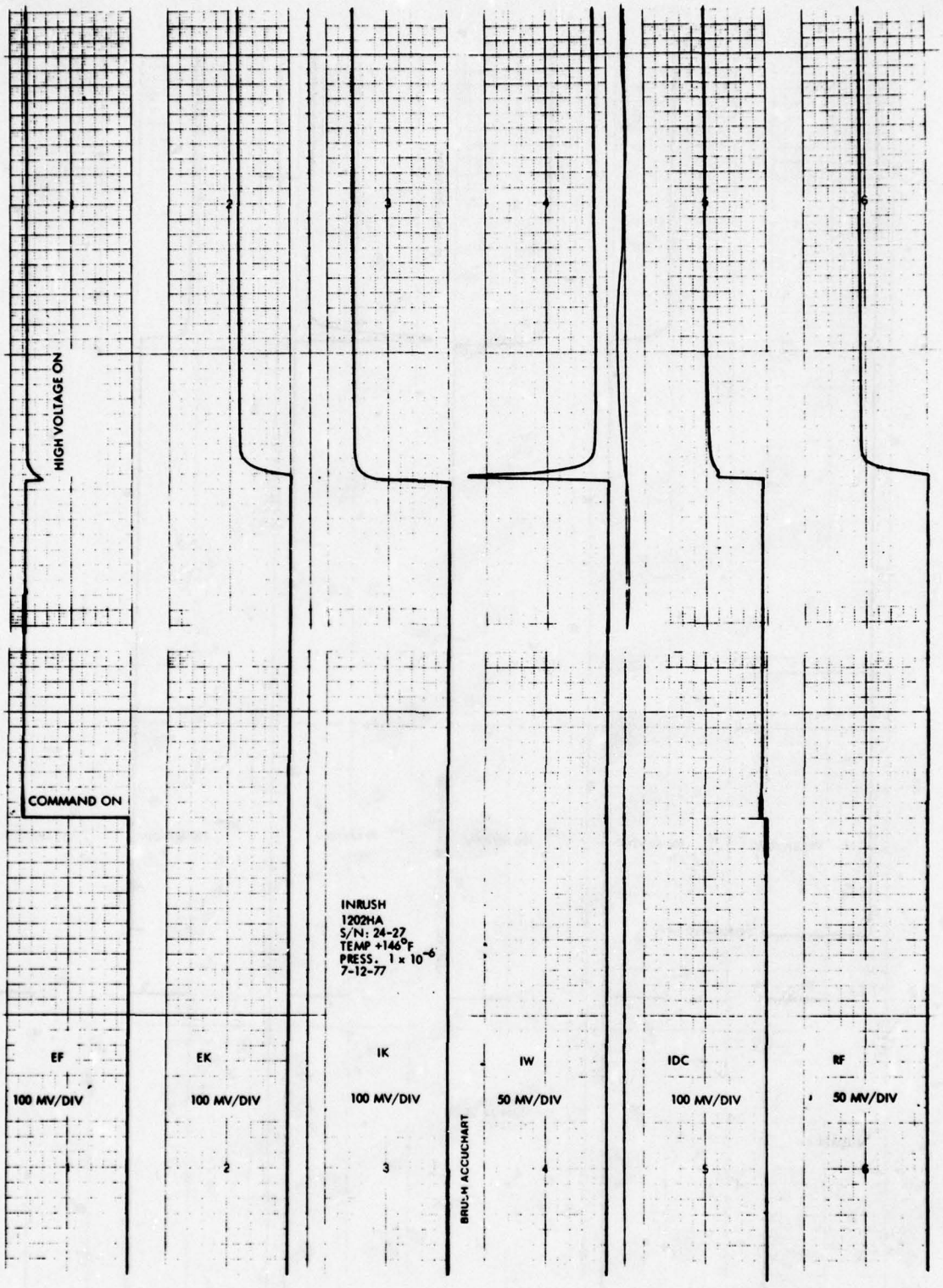

COMMAND ON
S/N 24-23
6-17-77
CHART SPEED 125 MM/SEC
Ef
EK
EK
IW
IDC
RF OUT
INRUSH CHARACTERISTICS
1202HA
S/N 24-23
6-17-77
TEMP. 80°F
PRESS. 1 x 10⁻⁶
100 MV/DIV
100 MV/DIV
100 MV/DIV
10 MV/DIV
100 MV/DIV
50 MV/DIV


125 MM/SEC
BRUSH ACCUCHART
COMMAND ON
NUMBER 2
EF 100 MV/DIV
ER 100 MV/DIV
IK 100 MV/DIV
IW 50 MV/DIV
IDC 100 MV/DIV
RF 50 MV/DIV
1202HA
S/N 24-23
INRUSH
6-22-77


VOLTAGE TURN ON
COMMAND
S/N 24-25
6-13-77
CHART SPEED 125MM/SEC FOR HIGH VOLTAGE TURN ON
EF
EK
IK
IW
IIN
RF OUT
NUMBER 3
INRUSH CHARACTERISTICS
1202HA
S/N:
1202HA
S/N: 24-25
6-13-77
TEMP. 80°F
PRESS. 1 x 10⁻⁶
100 MV/DIV
100 MV/DIV
100 MV/DIV
50 MV/DIV
100 MV/DIV
50 MV/DIV


125 MW/MIN FOR 2 M/NS
S/N 24-25
6-17-77
125 MW/SEC FOR HI VOLTAGE TURN ON
EF
100 MV/DIV
EK
100 MV/DIV
IK
100 MV/DIV
IW
50 MV/DIV
IIN
100 MV/DIV
RF OUT
100 MV/DIV
INRUSH CHARACTERISTICS
1202HA
S/N: 24-25
6-17-77
TEMP. +80°F
PRESS. 1 x 10⁻⁶
NUMBER 3


BRUSH ACCUCHART
125 MM/SEC
Gould Inc. Instrument Systems Division
EF 100 MV/DIV
IK 100 MV/DIV
IK 100 MV/DIV
IW 50 MV/DIV
IDC 100 MV/DIV
RF
50 MV/DIV
COMMAND ON
INRUSH
S/N 24-25
6-22-77
NUMBER 3


HIGH VOLTAGE ON
COMMAND ON
INRUSH
1202HA
S/N: 24-27
TEMP +146°F
PRESS. 1 x 10⁻⁶
7-12-77
EF
100 MV/DIV
1
EK
100 MV/DIV
2
IK
100 MV/DIV
3
IW
50 MV/DIV
4
IDC
100 MV/DIV
5
RF
50 MV/DIV
6
BRUSH ACCUCHART

APPENDIX A-6

HLTWTA OPERATING DATA SUMMARY
DURING UNIT AND SYSTEM LEVEL GROUND TESTING

EC A HL TWTH. S/N 14-14 S/C 7 PAGE 1 OF 2

TEST-AT HUGHES EDD	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (MA.)	E_F (V.)	I_W (MA.)	E_K (V.)	RF dBm INPUT	RF dBm OUTPUT
PRE-BURN-IN 0 HR.	5-14-6			75	28	3.45	54.5	5.65	0.40	3840	-2.8	43.30
END BURN-IN	5-28-6	333.7	333.7	125								
INITIAL FUNCTIONAL	6-1-6	3	336.7	75	23-33	3.5	54.5	5.6	0.45	3830	-2.85	43.23
	6-2-6	2	338.7	75	28							
VIBRATION-(PRE.)	6-2-6	0.5			28	3.50(3.5)	54.5	5.6	0.45	3830	-2.85	43.23
-(POST)	6-2-6		339.2		28	3.49(3.5)	54.5	5.6	0.45	3830	-2.85	43.18
THERMAL VACUUM	6-4-6	14.0	353.2	60	23-33	3.50	54.5	5.6	0.45	3820	-2.65	43.23
	6-4-6			146	23-33	3.50	55	5.6	0.60	3820	-2.75	43.23
FINAL FUNCTIONAL	6-7-6	1.0	354.2	75	23-33	3.50	54.5	5.6	0.45	3830	-2.70	43.15
	6-8-6	6.5	360.7	75	23-33							
	6-9-6	3.0	363.7	75	28							
INSTALLED IN S/C ≃	7-31-6 to 10-28-6	150.2	513.8									
REWORK 05-INITIAL	10-29-6	0.75		75	28	3.51(3.9)	54.5	5.6	0.50	3830	-2.6	43.26
POST	10-30-6	0.75		75	28-33	3.8	54.5	5.6	0.50	3850	-2.57	43.30
FINAL	10-31-6	0.75	516.1	75	28-33	3.51(3.9)	54.5	5.6	0.50	3830	-2.55	43.35
INSTALLED IN S/C ≃	11-1-6		516.1									
LIMITS						105 WATTS	60 MAX.	5.2≃5.6	0.22-5	3760-4000	-	-

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EC A HL TWTA. S/N 14-14

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (ma.)	E_F (V.)	I_W (ma)	E_K (V.)	RF-TLM dB INPUT	RF-TLM dB OUTPUT
CPT-1	9-13-6	24.7		100	≃31.5	3.16	54.4	5.61	0.50	3829	BEFORE CONNECTOR REWORK	40.94
SSTT-(HOT)	9-23-6	13.9		107	≃31.5	3.19	54.7	5.62	0.55	3817		40.90
-(COLD)	9-25-6	11.0		60	≃31.5	3.05	54.2	5.57	0.48	3878		41.01
	9-26,27	10.9										
IST	10-9-6	10.5		99	≃31.5	3.11	54.2	5.59	0.53	3833		40.97
DR-07-030	11-4-6	3.0	523.1	106	≃31.5	3.25	54.5	5.62	0.53	3826		40.9
	11-8-6	16.9										
IST-2	12-8-6	11.2		104	≃31.5	3.17	54.5	5.62	0.55	3818		41.01
IST-3	12-12-6	10.2		104	≃31.5	3.17	54.5	5.62	0.53	3819		40.94
	11-13-6	—	583.0									
TV-E	12-14-6	14.9		88	≃31.5	3.14	54.5	5.62	0.53	3837		40.97
TV-W	12-16-6	19.9		101	≃31.5	3.17	54.5	5.62	0.55	3819		40.09
	12-17-6	2.4										
IST-4	12-18-6	29.2		110	≃31.5	3.17	54.5	5.62	0.55	3822		40.97
	12-27-6	—	711.0									
CPT-2	1-6-7	23.3										
	2-23-7	—	791.0	99	≃31.5	3.14	54.5	5.59	0.55	3833		40.94
IST-2B	3-14-7	38.2		100	≃31.5	3.14	54.5	5.62	0.55	3837		41.01
	3-19,22	23.8										
~~DR-607-098~~	3-21,22	0.6										
HAT-1	3-23-7	7.4		107	≃31.5	3.17	54.7	5.62	0.55	3830		40.83
	3-25-7	—	900.3									
HAT-2	4-11-7	9.4		104	≃31.5	3.16	54.5	5.62	0.55	3829		40.82
	5-4-7	—	909.7									
LIMITS						2.5-4.5	43-57	5.29-5.92	0-3.2	3540-4060		42.0 ± 2.5

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EC B HL TWTA S/N 1-10 S/C 7

TEST - HOURS AT 400	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS IIN (A.)	IK (MA.)	EF (V.)	IW (MA.)	EK (V.)	RF dBm INPUT	RF dBm OUTPUT
PRE-ENDUR.	8-11-6	1	1	75								
POST ENDUR.	8-14-6	0.5	1.5	75								
0 HRS. BURN-IN	8-30-6	0.2	1.7	75	28	2.6?	51	5.6	0.5	3780	≈-2.0	43.25
BURN-IN	9-14-6	370.4	372.1	125								
INITIAL FUNCTIONAL	9-14-6	1	373.1	75	23-33							
	9-15-6	5	378.1	75	23-33	3.35	51	5.65	0.35	3800	-2.15	43.20
VIBRATION - (PRE)	9-15-6	0.5	378.6	75	28	3.35(3.3)	51	5.65	0.35	3790	≈-2.0	43.5
- (POST)	9-15-6			75	28	3.33(3.4)	51	5.65	0.35	3790	≈-2.0	43.5
THERMAL VACUUM	9-16-6	9.5	388.1	60	23-33	3.30	51	5.65	0.35	3780	-2.55	43.20
	9-17-6	8.5	396.6	146	23-33	3.37	51	5.65	0.45	3720	-2.55	43.20
FINAL FUNCTIONAL	9-18-6	5.0	401.6	75	23-33	3.30	51	5.65	0.35	3800	-2.10	43.20
INSTALLED IN S/C 8	9-27-6 TO 11-12-6	85.3	486.9	75	—	—	—	—	—	—	—	—
REWORK - INITIAL	11-13-6	1.5		75	28	3.6	51	5.6	0.35	3790	-2.5	43.40
POST	11-16-6	1.0		75	28-33	3.6	51	5.65	0.35	3780	-2.5	43.44
FINAL	11-17-6	1.5	490.4	75	28-33	3.6	51	5.65	0.40	3770	-2.5	43.45
INSTALLED IN S/C 9	12-23-6 TO 3-21-7	8.0	498.4	75	—	—	—	—	—	—	—	—
INSTALLED IN S/C 7	3-21-7		498.4	—	—	—	—	—	—	—	—	—
LIMITS						105 WATTS	60 MAX	5.2-5.6	0.22-5	3760-[illegible]	—	—

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EC B HL TWTA. S/N 14-16

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP °F	DC. INPUT VOLTS	TELEMETRY READINGS IIN(A)	IK (ma)	EF (V.)	IM (ma)	EK (V.)	RF-TLM INPUT	RF-TLM OUTPUT
CPT-1 SSTT-(HOT) -(COLD) IST DR-07-030 IST-2 IST-3 TV-E TV-W IST-4 CPT-2 IST-2B		ALL S/C	THESE USING	TESTS WERE HL TWTA		PARAMETERS S/N 14		-15.		ON THE		
DR-007-098	3-22-7	28.7	527.1	98	≃31.5	2.99	51.2	5.65	0.43	3771	-	41.21
HAT-1	3-23-7 3-30-7 3-31,4-1	5.0 9.3 37	532.1 541.4 580.4	104	≃31.5	2.99	51.2	5.65	0.43	3767		41.13
HAT-2	4-11-7	6.6	587.0	105	≃31.5	2.98	51.2	5.65	0.43	3771		41.13
	5-4-7		587.0									
LIMITS						2.5-4.5	43-57	5.20-	0-3.2	3540-		42.0

NC A HL TWTA S/N 27-15 S/C 7

TEST- HOURS AT	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (mA.)	E_F (V.)	I_W (mA)	E_K (V.)	RF dBm INPUT	RF dBm OUTPUT
PRE-BURN-IN - O.M.	4-20-6				28	3.45	51	5.65	0.36	3830	-3.9	43.10
END BURN-IN	5-4-6	336	336	125								
INITIAL FUNCTIONAL	5-5-6	3	339	75	23-33	3.45	50.5	5.65	0.40	3820	-3.9	43.10
	5-6-6	5	346	75								
VIBRATION -(PRE)	5-7-6	0.5	346.5	75	28	3.46(3.5)	50.5	5.65	0.15	3800	-3.9	43.10
-(POST)	5-7-6					3.47(3.5)	50.5	5.65	0.15	3790	-3.9	43.10
THERMAL VACUUM	5-7-6	8	354.5	60	23-33	3.45	52	5.65	0.4	3810	-4.0	43.10
	5-8-6	6.5	361	146	23-33	3.5	52	5.7	0.9	3860	-4.0	43.10
FINAL FUNCTIONAL	5-10-6	4	365	75	23-33	3.45	52	5.65	0.35	3810	-3.7	43.15
	5-11-6	2	367	75	28							
INSTALLED IN S/C = AT TRW.	7-31-6 To 11-17-6	200.9	567.9									
REWORK O.S - INITIAL	12-3-6	0.75		75	28	3.8 ?	52	5.65	0.35	3830	-4.25	43.16
FINAL	12-3-6	0.75	569.4	75	28	3.8 ?	52	5.65	0.35	3840	-4.13	43.30
INSTALLED IN S/C = AT TRW	12-7-6		569.4									
LIMITS						105 Watts	60 max.	5.2 ≈ 5.6	0.22-5	3760-	—	—

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NCA HL TWTA. S/N 24-15 S/C 7

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP °F	DC. INPUT VOLTS	TELEMETRY READINGS IM(A)	IK(mA)	EF(V.)	IM(mA)	EK(V.)	RF-TLM dBm INPUT	RF-TLM dBm OUTPUT
BEFORE STUDY: CPT-1	1-28-6	21.5		95	≃31.5	3.12	52.3	5.64	0.54	3819		41.00
SSTT-(HOT)	9-23-6	14.1		102	≃31.5	3.14	52.3	5.68	0.56	3812		42.90
-(COLD)	9-25-6	14.7		56	≃31.5	3.04	52.1	5.60	0.39	3865		41.67
	9-25,27	31.6										
IST	10-7-6	7.9		93	≃31.5	3.08	52.3	5.65	0.52	3823		41.0
DR-07-030	11-10-6											
	11-4-6	6.6		98	≃31.5	3.16	52.3	5.65	0.54	3827		40.96
	11-12-6	—	567.9								BEFORE CONNECTOR REWORK	
IST-2	12-8-6	8.6	569.4	98	≃31.5	3.10	52.6	5.65	0.58	3812		41.0
	12-11-6	12.5										
IST-3	12-13-6	22.5		98	≃31.5	3.10	52.3	5.65	0.56	3812		41.0
TV-E	12-14-6	15.5		81	≃31.5	3.08	52.6	5.65	0.52	3823		41.09
TV-W	12-15-6	17.7										
	12-16-6	13.2		93	≃31.5	3.06	52.6	5.68	0.27	3773		23.57?
	12-19,20,21	44.5										
IST-4	12-18-6	13.2		102	≃31.5	3.12	52.6	5.65	0.60	3815		40.93
	12-27-6	—	724.9									
CPT-2	1-5,6	24.1		92	≃31.5	3.04	52.3	5.62	0.43	3842		41.00
	2-23-7	—	832.7									
IST-2B	3-13,14,15	33.7		96	≃31.5	3.10	52.59	5.65	0.56	3819		41.00
~~DR 007 098~~	3-15,16	37.5										
	3-19,20	9.8										
	3-21,22	16										
HAT-1	3-23-7	4.8		99	≃31.5	3.10	52.6	5.65	0.60	3819		40.96
	3-25-7	—	940.5									
HAT-2	4-11-7	4.9		103	≃31.5	3.13	52.6	5.67	0.64	3811		40.96
	5-4-7		945.4									
LIMITS						2.5-4.5	43-57	5.29-5.92	0-3.2	3540-4040		42.0

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NS -- ITL IWIM S/N 247-16 S/C 7 PAGE 1 of ...

TEST-	DATE	RUN TIME HRS TEST	RUN TIME HRS TOTAL	TEMP °F	DC INPUT VOLTS	TELEMETRY READINGS I_{IN} (A)	I_K (mA)	E_F (V)	I_{IW} (mA)	E_K (V)	RF dBm INPUT	RF dBm OUTPUT
PRE-ORBIT SOLATION TEST	5-19-6	1.0	1.0	75								
O.A.L. BURN-IN	5-20-6											
END BURN-IN	6-3-6	332	333	75	28	3.4	52	5.55	0.45	3830	-3.5	43.15
INITIAL FUNCTIONAL	6-3-6	2.0	335	75								
	6-4-6	5.0	340	75								
RETEST/REWORK OS	6-17-6	1.0	341	75								
INITIAL FUNCTIONAL	7-9-6	1.0	342	75	23-33							
	7-12-6	5.0	347	75	23-33	3.45	52	5.55	0.25	3850	-3.45	43.20
A-342	7-13-6	2.0	349	75	28							
THERMAL VACUUM	7-15-6	8.0	357	60	23-33	3.45	52.5	5.55	0.40	3850	-3.85	43.20
	7-16-6	10.0	367	146	23-33	3.45	53	5.55	0.90	3860	-3.95	43.20
VIBRATION -(PRE.)	7-17-6	—	—	75	28	3.40(3.45)	53	5.6	0.45	3850	≃-3.5	41.7
-(POST)	7-19-6	—	—	75	28	2.59(3.55)	53	5.6	0.45	3850	≃-3.5	41.7
FINAL FUNCTIONAL	7-20-6	4.0	371	75	23-33	3.50	52	5.55	0.40	3840	-3.60	43.15
	7-21-6	3.0	374	75	28							
INSTALLED IN S/C ≃	7-31-6 10-28-6	104.4	478.4	—	—	—	—	—	—	—	—	—
REWORK - INITIAL	10-29-6	0.8		75	28	3.8(3.4)	52.5	5.6	0.5	3860	-3.2	43.20
- POST	10-30-6	0.7		75	23-33	3.9	52.5	5.6	0.4	3870	-3.5	43.40
- FINAL	10-31-6	0.8	480.7	75	28	3.8	52.5	5.6	0.4	3850	-3.1	43.40
INSTALLED IN S/C ≃	11-1-6	—	480.7	—	—	—	—	—	—	—	—	—
LIMITS						3.8 MAX	60 MAX	5.2-5.6	0.22-5	3760-4000	—	—

NC 2 HL TWTA. S/N 24-16 S/C 7 PAGE 2 OF 2

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP °F	DC. INPUT VOLTS	TELEMETRY READINGS IW(A)	IK(mA)	EE(V)	IW(mA)	EK(V)	RF-TIMIT INPUT	RF-TIMIT OUTPUT
CPT-1	[illegible]	[illegible]		[illegible]	[illegible]	3,09	52.2	[illegible]	0.51	3854		41.37
SSTT-(HOT)	9-23-[illegible]	4.3		105	[illegible]	3.14	52.3	5.59	0.48	3850		41.25
-(COLD)	9-25-6	15.4		55	[illegible]	3.00	52.0	5.54	0.35	3872		41.42
IST	[illegible]	[illegible]		92	≃31.5	3.03	52.1	5.56	0.37	3863		41.25
DR-07-030	11-4-6	5.5		100	≃31.5	3.14	52.3	5.56	0.48	3854		41.17
IST-2	11-13-6	—	535.6	98	≃31.5	3,12	52.3	5,59	0,52	3846		41.21
IST-3	12-8-6	14.8		99	≃31.5	3,05	52.3	5.56	0,43	3858		41.17
TV-E	12-12-6	4.7		99	≃31.5	3,03	52.3	5,56	0.41	3870		41.29
TV-W	12-14-6	4.7		99	≃31.5	3,03	52.3	5,56	0.41	3863		41.29
IST-4	12-16-6	3.8		93	≃31.5	3,03	52.0	5,56	0,41	3863		41.29
CPT-2	12-18-6	5.7		103	≃31.5	3,07	52.3	5,59	0.50	3850		41.13
IST-2B	1-2-7	—	599.1	95	≃31.5	3,05	52.3	5,56	0,43	3858		41.17
DR-007-098	1-6-7	9										
HAT-1	2-22-7	—	678.4	90	≃31.5	3,05	52.0	5,54	0,46	3850		41.17
HAT-2	3-14-7	5.9		98	≃31.5	3,12	52.3	5,59	0,54	3833		41.2
	3-15-7	3.6										
	3-22-7	9.0		98	≃31.5	3,12	52.3	5,59	0,54	3842		41.13
	3-23-7	2.3		100	≃31,5	3,12	52,3	5,59	0,54	3842		41.13
	3-25-7	—	700.0									
	4-1-7	3.9		103	≃31.5	3,13	52,3	5,58	0,58	3837		41.13
	5-4-7	—	703.9									
LIMITS						2.5-4.5	48-54	5,23-[illegible]	0-3.2	3540-[illegible]	—	42.0

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ECH HL 1 WTA S/N 14-17 S/C 8

TEST- AT HUGHES EDD	DATE	RUN. TIME HRS. TEST	RUN. TIME HRS. TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (MA)	E_F (V.)	I_W (MA)	E_K (V.)	RF dBm INPUT	RF dBm OUTPUT
PRE-POTTING SWEEPS	9/1/76	1.0	1.0									
POST POTTING	9/8/76	0.5	1.5									
PRE-BURN-IN 0 HRS	9/15/76	0.5	2.0	75	28	3.4	52	5.6	0.3	3810	-4	43.60
END BURN-IN	9/23/76	334.4	336.4									
INITIAL FUNCTIONAL	9/30/76	4.6	341	75	23-33	3.4	52	5.65	0.3	3790	-4.0	43.37
	10/1/76	2	343	75								
VIBRATION (PRE)	10/1/76	0.5	343.5	75	28	3.42(3.4)	52.5	5.65	0.3	3800	-4.0	43.55
(POST)	10/1/76			75	28	3.42(3.4)	52.5	5.65	0.3	3800	-4.0	43.55
THERMAL VACUUM	10/4/76	11	354.5	60	23-33	3.38	52.5	5.6	0.3	3810	-4.10	43.37
	10/5/76	7	361.5	146	23-33	3.43	53	5.6	0.4	3820	-4.10	43.37
FINAL FUNCTIONAL	10/6/76	4	365.5	75	23-33	3.4	52	5.65	0.3	3800	-4.25	43.37
	10/7/76	4	369.5	75	28							
REWORK O.S.- INIT.	11/5/76	1.5	371	75	23-33	4.15?	52.5	5.65	0.3	3820	-4.35	43.35
POST REWORK	11/13/76	1.5	372.5	75	23-33	4.1 ?	52	5.65	3.0?	3810	-3.50	43.25
FINAL	11/14/76	1.0	373.5	75	23-33	4.15?	52	5.65	0.3	3800	-4.1	43.35
INSTALLED IN S/C ≃	11/17/77											
LIMITS						105 WATTS	60 max.	5.2≃5.6	0.22-5	3760-4000	—	—

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TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (m.A.)	E_F (V.)	I_W (m.A.)	E_K (V.)	RF TLM dBm INPUT	RF TLM dBm OUTPUT
CPT #1	11/20/77	11.3		94.4	≃31.5	3.00	53.1	5.37	0.18	3825		40.38
SSTT (HOT)				108.9	≃31.5	2.95	53.1	5,34	0.38	3878		41.87
(COLD)				60.8	≃31.5	2.77	51.1	5.53	0.73	3864		41.58
~~IST #1~~ NOT THIS TWTA	~~10/29/76~~			92.3		3.12	53.1	5.41	0.55	3870		41.98
IST #2	12/23/76	7.1	466.2	101	≃31.5	3.03	52.7	5.69	0.41	3757		41.91
IST #3	1/6/77	9.3		100	≃31.5	3.05	52.2	5,66	0.38	3779		41.87
	1/7/77	6.9										
TV EQ	1/8/77	27.8		86	≃31.5	2.86	52.4	5.66	0.35	3787		41.94
	1/9/77	13.3										
TV WS	1/11/77	10.0		99	≃31.5	3.03	52.7	5,66	0.38	3770		41.87
	1/12/77	3.5										
IST #4	1/13/77	3.0		107	≃31.5	3.05	52.4	5,69	0.41	3757		41.91
TV EQ	1/16/77	55.6		81	≃31.5	3.03	52.4	5.65	0.60	3796		—
TV WS	1/18/77		607.9	103	≃31.5	2.88	52.2	5.60	0.026?	3620?		—
	1/21/77	4.0										
	1/22/77	4.7										
CPT #2	1/25/77	5.7		90.9	≃31.5	2.98	52.4	5.63	0.33	3796		41.91
	2/16/77		637.3									
IST #2B	3/15/77	14.8		91.7	≃31.5	2.95	52.4	5.63	0.30	3822		41.90
HISTORY 1	3/23/77	1.9		102	≃31.5	3.02	52.4	5,65	0.38	3779		41.80
	3/25/77	25.0	746.8									
HISTORY 2	4/14/77	5.8		93	≃31.5	3.00	52.4	5.66	0.35	3792		41.87
	5/4/77		752.6									
LIMITS						2.5-4.5	43-57	5.29-5.92	0-3.2	3540-4060		42.0 dBm ±2

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M. EDE TTL TWTA SN 14-49 S/C 8 PAGE 1 OF 2

TEST- AT HUGHES EDD	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (mA.)	E_F (V.)	I_W (mA)	E_K (V.)	RF dBm INPUT	RF dBm OUTPUT
INITIAL INTEGRATION	8/30/76	1	1									
0 HOURS BURN-IN	9/2/76			75	28	3.3	36?	5.65	0.4	3840	-2.8	43.25
END BURN-IN	9/17/76	345	346									
INITIAL FUNCTIONAL	9/17/76	3	349	75								
		4	353	75	23-33	—	—	—	—	—	—	—
THERMAL VACUUM	9/18/76	12	365									
ENG. TEST	9/23/76	1	366									
		4	370									
RE-TEST INIT. FUNCT.	9/23/76	1	371	75	23-33	3.35	51	5.65	0.45	3830	-2.80	43.45
VIBRATION (PRE)	9/30/76	0.5	371.5	75	28	3.38(3.4)	51	5.65	0.5	3830	-2.8	43.25
(POST)	9/30/76				28	3.38(3.4)	51	5.65	0.5	3830	-2.8	43.25
THERMAL VACUUM	9/30/76	0.5	372.0									
	10/1/76	15	387	60	23-33	3.35	51	5.65	0.5	3830	-3.10	43.40
	10/2/76	4.5	391.5	146	23-33	3.45	49.5	5.65	0.7	3820	-3.10	43.40
FINAL FUNCTIONAL	10/4/76	4	395.5	75	23-33	3.35	51	5.65	0.5	3840	-2.8	43.43
	10/5/76	2	397.5	75	28							
	10/6/76	1	398.5	75	28							
REWORK O.S.-INT.	11/5/76	1.5	400	75	23-33	4.1?	51	5.65	0.45	3820	-3.05	43.37
POST REWORK	11/13/76	1.0	401	75	23-33	4.0?	51	5.65	0.45	3840	-2.90	43.36
FINAL	11/14/76	1.0	402	75	23-33	4.05?	51	5.65	0.45	3830	-2.80	43.28
INSTALLED IN S/C ≃	11/16/76											
LIMITS						105 WATTS	60 MAX.	5.2≈5.6	0.22-5	3760-4000	—	—

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EC B HL IWTM. UNITS

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (m.A.)	E_F (V.)	I_W (m.A.)	E_K (V.)	RF TLM dBm. INPUT	RF TLM dBm. OUTPUT
CPT #1	11/20/76	7.4		94.4	≃ 31.5	3.14	52.0	5.40	0.40	3745		41.40
SSTT (HOT)				109	≃ 31.5	3.14	52.0	5.65	0.43	3761		42.15
(COLD)				58.6		2.95	53.6	5.37	0.35	3814		42.47
~~IST #1~~	~~10/23/76~~	NOT	THIS T	WTH 97.8		~~2.99~~	~~52.3~~	~~5.65~~	~~0.40~~	~~3769~~		~~41.87~~
IST #2	12/23/76	4.6	472.8	101	≃ 31.5	2.98	51.0	5.69	0.53	3795		41.98
IST #3	1/6/77	2.8		109	≃ 31.5	2.98	51.0	5.69	0.55	3791		41.94
	1/7/77	5.9										
TV EQ	1/8/77	5.2		80	≃ 31.5	2.93	51.0	5.66	0.49	3829		42.01
	1/9/77	22.8										
TV WS	1/11/77	4.9		98	≃ 31.5	2.95	51.0	5.69	0.51	3808		41.94
	1/12/77	6.3										
IST #4	1/13/77	2.5		106	≃ 31.5	2.98	51.3	5.69	0.55	3791		41.98
TV EQ	1/16/77	14.3		80	≃ 31.5	2.97	51.0	5.63	0.71	3854		—
TV WS	1/18/77		537.5	100	≃ 31.5	2.83	51.0	5.65	0.21	3687		—
	1/22/77	24.4										
CPT #2	1/24/77		638.8	94.4	≃ 31.5	2.93	51.0	5.66	0.49	3820		41.98
	2/16/77											
IST #2B	3/16/77	20.7		96	≃ 31.5	2.97	51.0	5.68	0.51	3807		42.00
	3/22/77	1.6										
HISTORY 1	3/24/77	10.5		102	≃ 31.5	2.98	51.0	5.69	0.51	3804		41.94
	3/25/77	13.9	685.5									
HISTORY 2	4/14/77	6.2		98	≃ 31.5	2.95	51.0	5.66	0.51	3812		41.94
	5/4/77		691.7									
LIMITS						2.5-4.5	43-57	5.29-5.93	0-3.2	3540-4060		42.0 ± 2

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NC B HL TWTH S/N 24-18 S/C 8

TEST- AT HUGHES EDD	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{DI} (A)	I_K (mA)	E_F (V.)	I_{DJ} (mA)	E_K (V.)	RF dBm INPUT	RF dBm OUTPUT
INITIAL INTEGRATION	8/11/76	1.0	1.0									
POST POT FUNCT.	8/14/76	0.3	1.3									
PRE-BURN-IN 0 HRS.	8/20/76	0.2	1.5	75	28	4.65?	50.5	5.65	0.35	3830	≃-4.5	43.30
BURN-IN	6/20 [illegible]	369.4										
	9/7/76		370.9									
INITIAL FUNCT. (ITR)	9/7/76	3.0	373.9									
RETEST INITIAL FUNCT.	9/14/76	1.0	374.9	75								VARIOUS
(COMPLETED)	9/15/76	5.0	379.9	75	23-33	3.40	51	5.6	0.6	3820	-2.2	43.10
VIBRATION (PRE)	9/15/76	0.5	380.4	75	28	3.38(3.5)	51	5.6	0.6	3820	≃-2	43.10
(POST)						3.38(3.5)	51	5.6	0.6	3815	≃-2	43.10
THERMAL VACUUM	9/17/76	14.0	394.4	60	23-33	3.35	51	5.6	0.6	3830	-2.35	43.0
				146	23-33	3.4	52	5.6	1.0	3770	-2.35	43.0
FINAL FUNCTIONAL	9/18/76	5.0	399.4	75	23-33	3.4	51	5.6	0.6	3810	-2.10	43.10
(COMPLETED)	9/18/76	1.0	400.4		28							VARIOUS
INSTALLED IN S/C	9/22/76											
	11/10/76		499.5									
REWORK - INITIAL	11/13/76	1.5	501.0	75	28-33	4.0?	51	5.6	0.6	3840	-2.50	43.10
POST REWORK	11/16/76	1.5	502.5	75	28-33	4.0?	51	5.6	0.6	3830	-2.50	43.20
FINAL	11/17/76	1.5	504.0	75	28-33	4.05?	51	5.6	0.6	3830	-2.35	43.20
INSTALLED IN S/C ≃	11/17/76											
LIMITS						105 WATTS	60 MAX.	5.2-5.6	0.22-5	3760-4000	-	>43dBm.

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NCB HL TWTA S/N24-18 S/C 8

TEST	DATE	RUN. TIME HRS TEST	RUN. TIME HRS TOTAL	TEMP. °F	DC. INPUT VOLTS	TELEMETRY READINGS I_{IN} (A.)	I_K (mA.)	E_F (V.)	I_W (mA.)	E_K (V.)	RF TLM dBm. INPUT	RF TLM dBm. OUTPUT
CPT #1	11/20/76	8.4		90	≃31.5	2.88	51.2	5.48	0.88	3782		40.1
SSTT (HOT)				103	≃31.5	2.98	51.5	5.64	0.63	3749		40.02
(COLD)				51.1	≃31.5	2.86	53.6	5.45	0.50	3822		41.68
IST #1	10/29/76	14.1		94.4	≃31.5	2.95	51.5	5.64	0.61	3765		40.92
IST #2	12/23/76	7.3	578.3	98	≃31.5	2.94	51.5	5.64	0.65	3785		40.28
IST #3	1/6/77	8.0		106	≃31.5	2.94	51.6	5.64	0.67	3777		40 07
TV EQ	1/8/77	4.2		76	≃31.5	2.91	51.3	5.61	0.61	3808		40.21
TV WS	1/11/77	22.8		93	≃31.5	2.91	51.5	5.64	0.63	3789		40.14
IST #4	1/13/77	8.2		95	≃31.5	2.94	51.5	5.64	0.65	3789		40.07
TV EQ	1/16/77	14.7		70	≃31.5	2.91	51.5	5.61	0.76	3823		—
TV WS	1/18/77		636.6	92	≃31.5	2.91	51.5	5.64	0.42	3746		—
CPT #2	1/24/77 2/16/77	28.4	731.7	92.2	≃31.5	2.89	51.3	5.61	0.63	3812		40.00
IST #2B	3/16/77	28.1		97	≃31.5	2.91	51.2	5.64	0.65	3792		39.71
HISTORY 1	3/23/77 3/25/77	9.5 13.9	788.8	96	≃31.5	2.94	51.6	5.64	0.67	3781		39.57
HISTORY 2	4/14/77 5/4/77	6.6	795.4	100	≃31.5	2.94	51.5	5.64	0.67	3769		39.43

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SATELLITE A 3-7 — REV N — IST DATA SUMMARY — PAGE 5

PARAMETER	STEP	TEST PERFORMED: CPT	SSTT HOT	SSTT COLD	IST	DR-07-030	IST-2	IST-3	TOLERANCE
EC A LLTWT INPUT I	29	0.202	0.213	0.155	0.176	0.190 +	0.195	0.195	.15 - .32 A
HELIX V	29	1738	1741	1744	1741	1737 +	1731	1726	1570 - 2030 V
HELIX I	29	.076	0.097	0.067	0.079	0.225 +	0.228	0.234	0 - .65 MA
FIL V	29	3.82	3.76	4.12*	3.84	3.82 +	3.78	3.82	3.5 - 4.03 V
CATH I	29	5.00	5.07	4.87	5.01	5.02 +	5.01	5.01	4.0 - 5.8 MA
TEMP	29	88	100	54	88	95	93	93	
EC A HLTWT INPUT I	29	3.16	3.19	3.05	3.11	3.25	3.17	3.17	2.5 - 4.5 A
HELIX V	29	3829	3819	3878	3833	3826	3818	3819	3540 - 4060 V
HELIX I	29	0.500	0.550	0.475	0.525	0.525	0.550	0.525	0 - 3.2 MA
FIL V	29	5.61	5.62	5.57	5.59	5.62	5.62	5.62	5.29 - 5.92 V
CATH I	29	54.44	54.73	54.18	54.18	54.46	54.45	54.45	43 - 57 MA
TEMP	29	100	107	60	99	106	104	104	
NC A LLTWT INPUT I	29	0.188	0.220	0.168	0.188	0.177 +	0.185	0.185	.15 - .32 A
HELIX V	29	1717	1713	1733	1723	1691 +	1697	1700	1570 - 2030 V
HELIX I	29	0.217	0.220	0.225	0.220	0.050 +	0.052	0.057	0 - .65 MA
FIL V	29	3.96	3.94	4.16*	3.93	3.74 +	3.71	3.74	3.5 - 4.03 V
CATH I	29	5.45	5.49	5.39	5.44	4.96 +	4.97	4.97	4.0 - 5.8 MA
TEMP	29	84	96	49	81	89	84	86	
NC A HLTWT INPUT I	29	3.12	3.14	3.04	3.08	3.16	3.10	3.10	2.5 - 4.5 A
HELIX V	29	3819	3812	3865	3823	3827	3812	3812	3540 - 4060 V
HELIX I	29	0.54	0.560	0.389	0.520	0.540	0.580	0.560	0 - 3.2 MA
FIL V	29	5.64	5.68	5.60	5.65	5.65	5.65	5.65	5.29 - 5.92 V
CATH I	29	52.32	52.33	52.06	52.33	52.33	52.59	52.33	43 - 57 MA
TEMP	29	95	102	56	93	98	98	98	
CH 1 RCV LEVEL MONITOR	29	-57.73	-57.42	-57.42	-57.27	-57.12	-55.91	-56.21	
CH 3 RCV LEVEL MONITOR	29	-40.25	-41.04	-39.30	-40.57	-40.88	-41.5	-40.73	
EC OUTPUT PWR MONITOR	29	40.94	40.90	41.01	40.97	40.90	41.01	40.94	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	29	41.00	40.96	41.67	41.00	40.96	41.00	40.96	42 +/- 2 DBM

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SATELLITE 3-7

77R IST DATA SUMMARY

PAGE 5A

PARAMETER	REV H STEP	TEST PERFORMED: TV-E	TV-W	IST 4	CPT 2	IST 2B	HAT 1	HAT 2	TOLERANCE
EC A LLTWT INPUT I	29	0.183	0.189	0.201	0.195	0.195	0.195	0.195	.15 - .32 A
HELIX V	29	1737	1742	1726	1724	1739	1721	1731	1570 - 2030 V
HELIX I	29	0.222	0.234	0.234	.228	0.234	0.234	0.234	0 - .65 MA
FIL V	29	3.88	3.83	3.80	3.85	3.82	3.79	3.82	3.5 - 4.03 V
CATH I	29	4.94	5.01	5.01	5.01	5.01	5.01	5.01	4.0 - 5.8 MA
TEMP	29	67	82	97	88	90	95	94	
EC A HLTWT INPUT I	29	3.14	3.17	3.17	3.14	3.14	3.17	3.16	2.5 - 4.5 A
HELIX V	29	3837	3819	3822	3833	3837	3830	3829	3540 - 4060 V
HELIX I	29	0.525	0.550	0.550	.550	0.550	0.550	0.550	0 - 3.2 MA
FIL V	29	5.62	5.62	5.62	5.59	5.62	5.62	5.62	5.29 - 5.92 V
CATH I	29	54.45	54.45	54.45	54.45	54.45	54.73	54.45	43 - 57 MA
TEMP	29	88	101	110	99	100	107	104	
NC A LLTWT INPUT I	29	0.168	0.173	0.185	0.179	0.179	0.190	0.185	.15 - .32 A
HELIX V	29	1713	1707	1694	1707	1700	1700	1700	1570 - 2030 V
HELIX I	29	0.052	0.040	0.057	0.052	0.057	0.057	0.057	0 - .65 MA
FIL V	29	3.77	3.73	3.72	3.73	3.73	3.73	3.71	3.5 - 4.03 V
CATH I	29	4.97	4.89	4.97	4.97	4.97	4.97	4.96	4.0 - 5.8 MA
TEMP	29	54	67	91	86	84	89	91	
NC A HLTWT INPUT I	29	3.08	3.06	3.12	3.04	3.10	3.10	3.13	2.5 - 4.5 A
HELIX V	29	3823	3773	3815	3842	3819	3819	3811	3540 - 4060 V
HELIX I	29	0.520	0.270	0.600	0.433	0.560	0.600	0.639	0 - 3.2 MA
FIL V	29	5.65	5.68	5.65	5.62	5.65	5.65	5.67	5.29 - 5.92 V
CATH I	29	52.59	52.59	52.59	52.33	52.59	52.59	52.59	43 - 57 MA
TEMP	29	81	93	102	92	96	99	103	
CH 1 RCV LEVEL MONITOR	29	-56.51	-40.70	-56.51	-56.82	-57.12	-56.51	57.72	
CH 3 RCV LEVEL MONITOR	29	-39.30	-87.50	-40.25	-40.25	-40.41	-39.93	-41.51	
EC OUTPUT PWR MONITOR	29	40.97	40.09	40.97	40.94	41.01	40.83	40.82	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	29	41.09	29.57 **	40.96	41.00	41.00	40.96	40.96	42 +/- 2 DBM
TEST DATE		12/14/76	12/16/76	12/18/76	1/06/77	03-14-77	03-23-77	04-11-77	

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SATELLITE 3-7 IST DATA SUMMARY

REV N

PAGE 6

PARAMETER	STEP	TEST PERFORMED							TOLERANCE
		CPT	SSTT HOT	SSTT COLD	IST	DR-07-030	IST-2	IST-3	
EC B LLTWT INPUT I	53	0.223	0.341	0.192	0.223	0.196 +	0.189	0.195	.15 - .32 A
HELIX V	53	1756	1753	1781	1763	1736 +	1764	1758	1570 - 2030 V
HELIX I	53	0.053	0.055	0.043	0.055	0.088 +	0.096	0.096	0 - .65 MA
FIL V	53	4.06*	4.05*	4.31*	4.11*	3.85 +	3.89	3.87	3.5 - 4.03 V
CATH I	53	5.85*	5.85*	5.70	5.85*	5.21 +	5.21	5.21	4.0 - 5.8 MA
TEMP	53	96	103	58	93	100	95	98	
EC B HLTWT INPUT I	53	3.09	3.11	3.02	3.05	3.12	3.05	3.07	2.5 - 4.5 A
HELIX V	53	3788	3788	3846	3800	3792	3800	3792	3540 - 4060 V
HELIX I	53	0.325	0.325	0.325	0.300	0.325	0.325	0.325	0 - 3.2 MA
FIL V	53	5.61	5.65	5.57	5.59	5.62	5.62	5.62	5.29 - 5.92 V
CATH I	53	51.73	51.74	51.48	51.74	51.74	51.74	51.74	43 - 57 MA
TEMP	53	100	106	59	98	104	100	102	
NC B LLTWT INPUT I	53	0.188	0.204	0.197	0.197	0.211 +	0.198	0.198	.15 - .32 A
HELIX V	53	1730	1737	1751	1723	1732 +	1732	1719	1570 - 2030 V
HELIX I	53	0.097	0.100	0.118	0.106	0.258 +	0.260	0.260	0 - .65 MA
FIL V	53	3.67	3.76	3.58	3.64	3.89 +	3.92	3.91	3.5 - 4.03 V
CATH I	53	4.89	4.89	4.76	4.82	5.38 +	5.37	5.37	4.0 - 5.8 MA
TEMP	53	87	97	50	94	90	88	87	
NC B HLTWT INPUT I	53	3.09	3.14	3.00	3.03	3.14	3.12	3.05	2.5 - 4.5 A
HELIX V	53	3854	3850	3892	3863	3854	3846	3858	3540 - 4060 V
HELIX I	53	0.389	0.478	0.345	0.389	0.478	0.522	0.433	0 - 3.2 MA
FIL V	53	5.58	5.59	5.54	5.56	5.56	5.59	5.56	5.29 - 5.92 V
CATH I	53	52.00	52.28	52.01	52.01	52.28	52.28	52.28	43 - 57 MA
TEMP	53	100	103	55	82	100	98	99	
CH 1 RCV LEVEL MONITOR	53	-57.42	-57.88	-56.67	-57.88	-57.42	-56.21	-56.21	
CH 3 RCV LEVEL MONITOR	53	-39.62	-40.25	-39.46	-40.09	-39.93	-41.04	-40.09	
EC OUTPUT PWR MONITOR	53	41.12	41.12	41.27	41.23	41.16	41.23	41.20	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	41.34	41.25	41.42	41.25	41.17	41.21	41.17	42 +/- 2 DBM

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SATELLITE 3-7

7R IST DATA SUMMARY

PAGE 6A

PARAMETER	REV N STEP	TEST PERFORMED TV-E	TV-W	IST 4	CPT 2	IST 2B	DR-007 -098	HAT 1	TOLERANCE
EC B LLTWT INPUT I	53	0.177	0.183	0.195	0.189	0.189	0.195	0.201	.15 - .32 A
HELIX V	53	1763	1758	1752	1755	1758	1749	1761	1570 - 2030 V
HELIX I	53	0.090	0.090	0.090	0.090	0.096	0.096	0.096	0 - .65 MA
FIL V	53	3.98	3.94	3.89	3.91	3.89	3.89	3.87	3.5 - 4.03 V
CATH I	53	5.16	5.16	5.21	5.21	5.21	5.21	5.21	4.0 - 5.8 MA
TEMP	53	72	86	100	94	94	94	99	
EC B HLTWT INPUT I	53	3.05	3.05	3.07	3.05	3.05	2.99	2.99	2.5 - 4.5 A
HELIX V	53	3813	3800	3796	3800	3804	3771	3767	3540 - 4060 V
HELIX I	53	0.325	0.300	0.325	.325	0.325	0.425	0.425	0 - 3.2 MA
FIL V	53	5.62	5.62	5.62	5.62	5.62	5.65	5.65	5.29 - 5.97 V
CATH I	53	52.01	51.74	51.74	51.74	51.74	51.17	51.17	43 - 57 MA
TEMP	53	85	99	109	99	99	98	104	
NC B LLTWT INPUT I	53	0.158	0.168	0.208	0.188	0.198	0.198	0.198	.15 - .32 A
HELIX V	53	1739	1729	1729	1732	1729	1732	1713	1570 - 2030 V
HELIX I	53	0.260	0.260	0.260	.260	0.266	0.266	0.266	0 - .65 MA
FIL V	53	4.181*	3.99	3.92	3.91	3.91	3.78	3.92	3.5 - 4.03 V
CATH I	53	5.22	5.30	5.37	5.37	5.37	5.45	5.45	4.0 - 5.8 MA
TEMP	53	54	67	92	84	85	93	93	
NC B HLTWT INPUT I	53	3.03	3.03	3.07	3.05	3.05	3.12	3.12	2.5 - 4.5 A
HELIX V	53	3870	3863	3850	3858	3858	3833	3842	3540 - 4060 V
HELIX I	53	0.411	0.411	0.500	0.433	0.456	0.542	0.542	0 - 3.2 MA
FIL V	53	5.56	5.56	5.59	5.56	5.56	5.59	5.59	5.29 - 5.97 V
CATH I	53	52.28	52.01	52.28	52.28	52.01	52.28	52.28	43 - 57 MA
TEMP	53	80	93	103	95	96	98	100	
CH 1 RCV LEVEL MONITOR	53	-56.67	-56.36	-56.70	-56.97	-57.27	-56.36	-56.67	
CH 3 RCV LEVEL MONITOR	53	-39.36	-39.30	-39.62	-39.46	-39.78	-39.62	-40.25	
EC OUTPUT PWR MONITOR	53	41.27	41.20	41.20	41.20	41.27	41.05	40.83	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	41.29	41.29	41.13	41.17	41.17	41.21	41.13	42 +/- 2 DBM
TEST DATE		12/14/76	12/16/76	12/18/76	1/06/77	03-14-77	03-22-77	03-22-77	

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...7R IST DATA SUMMARY

PARAMETER	REV N STEP	TEST PERFORMED HAT 2							PAGE 6B TOLERANCE
EC B LLTWT INPUT I	53	0.195							.15 - .32 A
HELIX V	53	1763							1570 - 2030 V
HELIX I	53	0.090							0 - .65 MA
FIL V	53	3.79							3.5 - 4.03 V
CATH I	53	5.21							4.0 - 5.8 MA
TEMP	53	99							
EC B HLTWT INPUT I	53	2.98							2.5 - 4.5 A
HELIX V	53	3771							3540 - 4060 V
HELIX I	53	0.425							0 - 3.2 MA
FIL V	53	5.65							5.29 - 5.92 V
CATH I	53	51.17							43 - 57 MA
TEMP	53	105							
NC B LLTWT INPUT I	53	0.208							.15 - .32 A
HELIX V	53	1719							1570 - 2030 V
HELIX I	53	0.265							0 - .65 MA
FIL V	53	3.79							3.5 - 4.03 V
CATH I	53	5.44							4.0 - 5.8 MA
TEMP	53	95							
NC B HLTWT INPUT I	53	3.13							2.5 - 4.5 A
HELIX V	53	3837							3540 - 4060 V
HELIX I	53	0.584							0 - 3.2 MA
FIL V	53	5.58							5.29 - 5.92 V
CATH I	53	52.27							43 - 57 MA
TEMP	53	103							
CH 1 RCV LEVEL MONITOR	53	-57.57							
CH 3 RCV LEVEL MONITOR	53	-41.67							
EC OUTPUT PWR MONITOR	53	40.82							42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	41.13							42 +/- 2 DBM
TEST DATE		04-11-77							

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SATELLITE 3-8 — .7R IST DATA SUMMARY — PAGE 5

PARAMETER	PEV N STEP	TEST PERFORMED CPT	SSTT NOL	SSTT LOLO	IST 1		IST 2	IST 3	TOLERANCE
EC A LLTWT INPUT I	29	.260	.246	.229	0.208	C/O	.218	0.218	.15 - .32 A
HELIX V	29	1787.47	1790.6	1839.39	1778	C/O	1825	1825	1570 - 2030 V
HELIX I	29	.522	.525	.637	0.132	C/O	0.175	0.169	0 - .65 MA
FIL V	29	3.932	3.795	3.87	3.80	C/O	3.759	3.717	3.5 - 4.01 V
CATH I	29	5.56	4.47	5.49	4.61	C/O	5.568	5.568	4.0 - 5.8 MA
TEMP	29	83.16	101.2	54.5	86.33		93	92	
EC A HLTWT INPUT I	29	3.00	2.950	2.767	3.12	C/O	3.025	3.050	2.5 - 4.5 A
HELIX V	29	3896.32	3878.1	3864.5	3870	C/O	3757	3779	3540 - 4060 V
HELIX I	29	.178	.375	.725	0.559	C/O	0.496	0.379	0 - 3.2 MA
FIL V	29	5.323	5.34	5.53	5.40	C/O	5.686	5.658	5.29 - 5.92 V
CATH I	29	53.06	53.06	51.12	53.07	C/O	52.69	52.15	43 - 57 MA
TEMP	29	91.35	101.9	60.78	92.29		101	100	
NC A LLTWT INPUT I	29	.178	.219	.197	.216	C/O	0.210	0.218	.15 - .32 A
HELIX V	29	1790	1790.0	1733.33	1806	C/O	1702	1708	1570 - 2030 V
HELIX I	29	.236	.219	.219	0.264	C/O	0.170	0.165	0 - .65 MA
FIL V	29	3.791	3.791	3.80	3.75	C/O	3.872	3.900	3.5 - 4.01 V
CATH I	29	4.000	4.000	4.000	4.07	C/O	5.067	4.993	4.0 - 5.8 MA
TEMP	29	82.3	101.2	52.44	82.30		81.0	86	
NC A HLTWT INPUT I	29	2.61	2.64	2.80	3.10	C/O	2.982	2.982	2.5 - 4.5 A
HELIX V	29	3901.06	3846.3	3831.24	3812	C/O	3762	3777	3540 - 4060 V
HELIX I	29	.563	1.15	.299	0.880	C/O	0.501	0.501	0 - 3.2 MA
FIL V	29	5.67	5.508	5.62	5.54	C/O	5.668	5.632	5.29 - 5.92 V
CATH I	29	50.47	52.59	49.67	52.86	C/O	51.59	51.59	43 - 57 MA
TEMP	29	91.76	102.0	55.1	92.63		96.0	94	
CH 1 RCV LEVEL MONITOR	29	66.4	-57.86	-58.02	-57.87		-57.70	-57.87	
CH 3 RCV LEVEL MONITOR	29	46.45	-42.72	-46.85	-40.04		-40.56	-40.40	
EC OUTPUT PWR MONITOR	29	40.8	41.87	41.58	41.98	C/O	41.91	41.87	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	29	40.2	40.08	41.6	41.45	C/O	40.28	40.07	42 +/- 2 DBM
TEST DATE					10-29-76		12/23/76	01/06/77	

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REV N-

777R IST DATA SUMMARY

PARAMETER	STEP	Ø 1 TEST PERFORMED							TOLERANCE
		TV EQ	TV WS	IST 4	TV EQ	TV WS	CPT 2	IST 2B	
EC A LLTWT INPUT I	29	0.159	0.261	0.218	.139 *	.178	.178	.198	.15 - .32 A
HELIX V	29	1829	1841	1829	1829	1835	1829	1831	1570 - 2030 V
HELIX I	29	0.175	0.175	0.175	.175	.164	.175	.169	0 - .65 MA
FIL V	29	3.884	3.815	3.725	4.02	3.79	3.895	3.90	3.5 - 4.03 V
CATH I	29	5.568	5.568	5.568	5.56	5.56	5.568	5.35	4.0 - 5.8 MA
TEMP	29	69	82	98	61	86	81.44	83.1	
EC A HLTWT INPUT I	29	2.858	3.026	3.050	3.026	2.882	2.978	2.95	2.5 - 4.5 A
HELIX V	29	3787	3770	3757	3796	3820	3796	3822	3540 - 4060 V
HELIX I	29	0.352	0.379	0.406	.526	.026	.325	.298	0 - 3.2 MA
FIL V	29	5.658	5.658	5.686	5.65	5.60	5.631	5.63	5.29 - 5.92 V
CATH I	29	52.42	52.69	52.42	52.42	52.15	52.42	52.4	43 - 57 MA
TEMP	29	86	99	107	81	103	99.91	91.7	
NC A LLTWT INPUT I	29	0.178	0.210	0.226	.186	.202	.202	.193	.15 - .32 A
HELIX V	29	1708	1711	1711	1711	1708	1724	1711	1570 - 2030 V
HELIX I	29	0.165	0.170	0.170	.143	.132	.159	.153	0 - .65 MA
FIL V	29	3.900	3.900	3.886	3.94	3.87	3.900	3.91	3.5 - 4.03 V
CATH I	29	4.993	5.067	5.067	4.92	4.99	4.993	4.99	4.9 - 5.8 MA
TEMP	29	57	73	88	48	70	77.14	78.8	
NC A HLTWT INPUT I	29	2.792	2.982	2.982	3.00	2.876	2.956	2.93	2.5 - 4.5 A
HELIX V	29	3781	3758	3766	3803	3814	3778	3818	3540 - 4060 V
HELIX I	29	0.473	0.501	0.501	.340	.083	.415	.473	0 - 3.2 MA
FIL V	29	5.642	5.668	5.642	5.64	5.64	5.642	5.91	5.29 - 5.92 V
CATH I	29	51.59	51.59	51.96	51.59	51.59	51.59	51.5	43 - 57 MA
TEMP	29	80	93	95	71	95	84.02	86.6	
CH 1 RCV LEVEL MONITOR	29	-56.90	-56.73	-57.38	No Test	No Test	-57.7	-57.3	
CH 3 RCV LEVEL MONITOR	29	-39.60	-39.76	-40.72	No Test	No Test	-40.4	-40.2	
EC OUTPUT PWR MONITOR	29	41.94	41.87	41.91	No Test	No Test	41.91	41.9	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	29	40.21	40.21	40.07	No Test	No Test	40.07	39.8 *	42 +/- 2 DBM
TEST DATE		01-08-77	01-11-77	01-13-77	01-16-77	01-18-77	1-24-77	3-15-77	

SATELLITE

R IST DATA SUMMARY

PARAMETER	REV N STEP	TEST PERFORMED HIST 1	HIST 2						PAGE 56 TOLERANCE
EC A LLTWT INPUT I	29	.218	.218						.15 - .32 A
HELIX V	29	1816	1825						1570 - 2030 V
HELIX I	29	0.175	0.175						0 - .65 MA
FIL V	29	3.725	3.86						3.5 - 4.03 V
CATH I	29	5.56	5.50						4.0 - 5.8 MA
TEMP	29	93.5	83.0						
EC A HLTWT INPUT I	29	3.02	3.00						2.5 - 4.5 A
HELIX V	29	3779	3792						3540 - 4060 V
HELIX I	29	0.379	0.352						0 - 3.2 MA
FIL V	29	5.65	5.66						5.29 - 5.92 V
CATH I	29	52.4	52.4						43 - 57 MA
TEMP	29	102	93						
NC A LLTWT INPUT I	29	.210	.218						.15 - .32 A
HELIX V	29	1718	1718						1570 - 2030 V
HELIX I	29	0.132	0.170						0 - .65 MA
FIL V	29	3.88	3.87						3.5 - 4.03 V
CATH I	29	4.99	5.07						4.0 - 5.8 MA
TEMP	29	89	88						
NC A HLTWT INPUT I	29	2.98	2.98						2.5 - 4.5 A
HELIX V	29	3770	3770						3540 - 4060 V
HELIX I	29	0.473	0.501						0 - 3.2 MA
FIL V	29	5.64	5.67						5.29 - 5.92 V
CATH I	29	51.5	51.6						43 - 57 MA
TEMP	29	96.6	99						
CH 1 RCV LEVEL MONITOR	29	-57.70	-57.54						
CH 3 RCV LEVEL MONITOR	29	-39.92	-39.76						
EC OUTPUT PWR MONITOR	29	41.8	41.87						42 +/- 2 DBM
NC OUTPUT PWR MONITOR	29	39.64 *	39.50*						42 +/- 2 DBM
TEST DATE		3-23-77	4-14-77						

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ATELLITE 3-8

IST DATA SUMMARY

REV N

PAGE 6

PARAMETER	STEP	TEST PERFORMED: CPT	SSTI HOT	SSTI COLD	IST 1		IST 2	IST 3	TOLERANCE
C B LLTWT INPUT I	53	.266	.298	.218	0.209	C/O	0.195	0.188	.15 - .32 A
HELIX V	53	1819.33	1883.84	1825.78	1858	C/O	1700	1703	1570 - 2010 V
HELIX I	53	.149	.247	.114	0.254	C/O	0.063	0.063	0 - .65 MA
FIL V	53	3.72	3.49	3.72	3.64	C/O	3.796	3.809	3.5 - 4.01 V
CATH I	53	5.62	6.74*	5.46	6.74*	C/O	5.453	5.453	4.0 - 5.8 MA
TEMP	53	90.01	101.23	55.8	93.49		98.0	102	
C B HLTWT INPUT I	53	3.14 A	3.14 A	2.95 A	2.99	C/O	2.977	2.977	2.5 - 4.5 A
HELIX V	53	3765.28	3761.2	3814.26	3769	C/O	3795	3791	3540 - 4060 V
HELIX I	53	.400	.425	.350	0.400	C/O	0.533	0.553	0 - 3.2 MA
FIL V	53	5.40	5.65	5.373	5.65	C/O	5.686	5.686	5.29 - 5.92 V
CATH I	53	52.01	52.01	53.61	52.28	C/O	51.01	51.01	43 - 57 MA
TEMP	53	91.35	108.95	58.6	97.79		101	109	
NC B LLTWT INPUT I	53	.253	.253	.218	0.195	C/O	0.198	0.203	.15 - .32 A
HELIX V	53	1661.07	1658.2	1687.05	1666	C/O	1747	1735	1570 - 2010 V
HELIX I	53	.209	.214	.174	0.215	C/O	0.074	0.079	0 - .65 MA
FIL V	53	4.02	3.78	4.32*	4.01*	C/O	4.153*	3.787	3.5 - 4.01 V
CATH I	53	4.42	4.42	4.29	4.43	C/O	5.316	5.416	4.0 - 5.8 MA
TEMP	53	84.88	96.93	49.02	83.16		86.0	91	
NC B HLTWT INPUT I	53	2.88	2.98	2.86	2.95		2.938	2.938	2.5 - 4.5 A
HELIX V	53	3781.62	3748.9	3822.43	3765		3785	3777	3540 - 4060 V
HELIX I	53	.076	.625	.500	0.605		0.652	0.671	0 - 3.2 MA
FIL V	53	5.48	5.64	5.45	5.61		5.641	5.611	5.29 - 5.92 V
CATH I	53	51.17	51.47	53.611	51.48		51.53	51.59	43 - 57 MA
TEMP	53	90.04	101.00	51.07	94.35		98.0	106	
CH 1 RCV LEVEL MONITOR	53	-55.2	-58.1	-58.18	58.03		-57.87	-57.70	
CH 3 RCV LEVEL MONITOR	53	-45.4	-42.7	43.21	-40.72		-40.24	-40.56	
EC OUTPUT PWR MONITOR	53	41.4	42.15	42.47	41.87		41.98	41.94	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	40.1	40.02	41.68	40.92		40.28	40.07	42 +/- 2 DBM
					10-29-76		12-23-76	01-06-77	

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SATELLITE .....

77R IST DATA SUMMARY

REV N

PARAMETER	STEP	Ø 1 TEST PERFORMED							PAGE 6A TOLERANCE
		TV EQ	TV WS	IST 4	TV EQ	TV WS	CPT 2	IST 2B	
EC B LLTWT INPUT I	53	0.165	0.173	0.188	.157	.173	.180	.180	.15 - .32 A
HELIX V	53	1720	1700	1691	1717	1700	1703	1702	1570 - 2030 V
HELIX I	53	0.063	0.063	0.063	.063	.052	.063	.063	0 - .65 MA
FIL V	53	3.984	3.872	3.809	3.96	3.86	3.821	3.78	3.5 - 4.03 V
CATH I	53	5.302	5.377	5.453	5.37	5.45	5.453	5.37	4.0 - 5.8 MA
TEMP	53	67	84	100	59	92	88.33	93	
EC B HLTWT INPUT I	53	2.930	2.954	2.977	2.97	2.83	2.930	2.97	2.5 - 4.5 A
HELIX V	53	3829	3808	3791	3854	3697	3820	3807	3540 - 4060 V
HELIX I	53	0.494	0.513	0.553	.710	.218	.494	.513	0 - 3.2 MA
FIL V	53	5.658	5.686	5.686	5.63	5.65	5.658	5.68	5.29 - 5.92 V
CATH I	53	51.01	51.01	51.27	51.0	51.0	51.01	51.0	43 - 57 MA
TEMP	53	80	98	106	80	100	94.35	96	
NC B LLTWT INPUT I	53	0.182	0.193	0.198	.178	.193	.198	.202	.15 - .32 A
HELIX V	53	1747	1760	1747	1760	1735	1735	1763	1570 - 2030 V
HELIX I	53	0.068	0.074	0.079	.057	.029	.074	.073	0 - .65 MA
FIL V	53	4.255*	4.065*	3.850	4.19 *	3.98	3.989	3.86	3.5 - 4.03 V
CATH I	53	5.277	5.277	5.316	5.20	5.27	5.277	5.34	4.0 - 5.8 MA
TEMP	53	55	72	88	51	78	79.72	85	
NC B HLTWT INPUT I	53	2.913	2.913	2.938	2.91	2.91	2.887	2.91	2.5 - 4.5 A
HELIX V	53	3808	3789	3789	3823	3746	3812	3792	3540 - 4060 V
HELIX I	53	0.609	0.631	0.652	.761	.422	.631	.652	0 - 3.2 MA
FIL V	53	5.614	5.641	5.641	5.61	5.64	5.614	5.64	5.29 - 5.92 V
CATH I	53	51.27	51.53	51.53	51.5	51.5	51.27	51.5	43 - 57 MA
TEMP	53	76	93	95	70	92	89.19	97	
CH 1 RCV LEVEL MONITOR	53	-57.70	-57.38	57.38	No Test	No Test	-57.7	-57.3	
CH 3 RCV LEVEL MONITOR	53	-39.76	-40.08	40.72	No Test	No Test	-40.5	-40.2	
EC OUTPUT PWR MONITOR	53	42.01	41.94	41.98	No Test	No Test	41.98	42.0	42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	40.21	40.14	40.07	No Test	No Test	40.00	39.71 *	42 +/- 2 DBM
TEST DATE		01-08-77	01-11-77	01-13-77	01-16-77	01-18-77	01-24-77	3-16-77	

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TEST DATA SUMMARY

PAGE 68

PARAMETER	REV N STEP	TEST PERFORMED IST 2B	HIST 1	HIST 2					TOLERANCE
EC B LLTWT INPUT I	53	.180	.188	.180					.15 - .32 A
HELIX V	53	1702	1703	1703					1570 - 2030 V
HELIX I	53	.063	.063	.063					0 - .65 MA
FIL V	53	3.78	3.78	3.80					3.5 - 4.03 V
CATH I	53	5.37	5.45	5.38					4.0 - 5.8 MA
TEMP	53	93	98	93					
EC B HLTWT INPUT I	53	2.97	2.96	2.95					2.5 - 4.5 A
HELIX V	53	3807	3804	3812					3540 - 4060 V
HELIX I	53	.513	.513	.513					0 - 3.2 MA
FIL V	53	5.68	5.69	5.66					5.29 - 5.92 V
CATH I	53	51.0	51.0	51.0					43 - 57 MA
TEMP	53	96	102	98					
NC B LLTWT INPUT I	53	.202	.203	.202					.15 - .32 A
HELIX V	53	1763	1735	1735					1570 - 2030 V
HELIX I	53	.073	.079	0.079					0 - .65 MA
FIL V	53	3.86	3.86	3.82					3.5 - 4.03 V
CATH I	53	5.34	5.42	5.42					4.0 - 5.8 MA
TEMP	53	85	90	92					
NC B HLTWT INPUT I	53	2.91	2.94	2.94					2.5 - 4.5 A
HELIX V	53	3792	3781	3769					3540 - 4060 V
HELIX I	53	.652	.674	0.674					0 - 3.2 MA
FIL V	53	5.64	5.64	5.64					5.29 - 5.92 V
CATH I	53	51.2	51.6	51.53					43 - 57 MA
TEMP	53	97	96	100					
CH 1 RCV LEVEL MONITOR	53	-57.3	-57.7	-57.7					
CH 3 RCV LEVEL MONITOR	53	-40.2	-39.9	-39.6					
EC OUTPUT PWR MONITOR	53	42.0	41.94	41.94					42 +/- 2 DBM
NC OUTPUT PWR MONITOR	53	39.71*	39.57 *	39.43*					42 +/- 2 DBM
TEST DATE		3-16-77	3-23-77	4-14-77					

APPENDIX B

PREVIOUS HLTWTA FAILURE ANALYSIS REPORTS

All testing reported in this section was performed under ambient pressure and room temperature conditions unless specifically stated otherwise.

APPENDIX B-1

IOC: TESTING OF TWTA POWER SUPPLY BREADBOARD, 17 FEB 1975, D.L. CRONIN

TRW
SYSTEMS GROUP

INTEROFFICE CORRESPONDENCE

TO: J. L. Streisand CC: DATE: 17 February 1975

SUBJECT: Testing of TWTA Power Supply Breadboard

FROM: D. L. Cronin

BLDG.	MAIL STA.	EXT.
R2	2162	50585

References: 1) D. Cronin to J. Streisand dated 21 October 1974, "Investigation of ECHL #1 TWTA Anomaly on 777 S/C 4"

2) D. Cronin to J. Streisand dated 23 October 1974, "Testing to Duplicate ECHL #1 TWTA Anomaly 777 S/C 4"

Tests were conducted on a TWTA power supply breadboard/dummy load at H. A. C. Torrance Facility on 16 January 1975. The test procedure was approximately as outlined in the October 23rd memo referenced above.

The breadboard is used to power TWT's from several programs and must have modification made to meet the specification of a particular tube. The breadboard was not vigorously configured to the 777 specification. In particular:

- The heater series regulator was set high at 5.7V instead of 5.4 volt.
- Input and helix current resistors R11, R3, R1 and R2 did not have the absolute values called out on the 777 drawings. Trip level of input and helix current were set but tests for calibration shift with failure of these resistors were inconclusive.

Test data and oscilloscope pictures of wave forms are attached.

Test Results

1. Single component failures which inhibit the main voltage regulation loop and keep the start circuit control loop in operation had the following effects on performance.

SYSTEMS 0150 REV. 8-67

- Heater current and voltage was 25% below normal settings during and after the heater warm-up period.

- The time out period shifted from 90 seconds to 125 seconds.

- The 19 volt bus regulated at 15 VDC.a lower voltage than had been anticipated. The effect accounts for the extended time out period and low heater current.

  No explanation for the low bus voltage was found. Accrued worst case tolerance on parts which establish this parameter would result in a bus voltage no lower than 15.6 VDC. Second order effects such as filter Q or transistor Betas may be on explanation.

- It is also possible that a lower value zener than the VR3 (1N965B) as specified for the program was installed in the breadboard. This part is not critical in normal operation.

- Sustained oscillation occurred with random low frequency components during the first few minutes after high voltage turn on. Cathode ripple varied from 180 to 400 time normal. Cathode ripple in front of the HV πsection filters was not read but based on a 190:1 transformer ratio and 2.5V P-P on the DC bus, would have been 450V P-P.

  The frequency of oscillation was approximately 2700 H_3 as opposed to 800 H_3 or less as predicted. Had oscillation been at the lower frequency ripple amplitude would have been approximately 20 db higher. An explanation for the frequency difference may be non linear second order effects such as peak charging filters and circuit Q's.

2. Single component failure tests which initiate the over current protective circuitry gave the following results:

   - Removal of R_{11} caused the unit to trip off shortly after the unit was turned on and during heater warm-up.

- Removal of R_3 had no effect. R_3 (SIT) and R_{11} were thought to be 1.82K and approximately equal. However, in the breadboard R_3 was 33 K Ω.

- Removal of C_3 (33 μf) resulted in a normal heater time out but executed the protective circuitry a few seconds after HV was turned on.

Conclusions

1. Single part failure in the main voltage regulation loop resulted in reduced input current as indicated by telemetry during the ECHL 1 TWTA. Anomaly on 777 S/C 4. However, heater time out extended from 90 to 125 seconds. Heater time out during the anomaly remained constant at approximately 90 seconds which would indicate that this was not the failure mode.

2. Single part failure in the protective circuitry will give a normal time out but trip the unit off when high voltage is applied. However, input current would not reduce as indicated by telemetry during the anamoly.

3. The ripple voltage due to oscillation of the power supply was large compared to normal operation but probably not large enough to damage or influence the dynamic operation of the TWTA.

4. If a TWT had been used for a load during this test the low H. V. output would have probably caused a helix over current trip.

Test Number 2. Component Failure in the Protective Circuits

Condition: Disconnect capacitor C2 (33 μf) all other conditions nominal

Results: 1. Normal heater time out and all reading nominal

2. Unit tripped off after short time delay (1 to 10 sec) when high voltage came on.

Test Number 3. Component Failure in the Main Voltage Regulator Circuit

Condition: +5 VDC supply removed

A. Reading Taken During Heater Time Out

1.	Heater Current		310 ma
2.	Heater Voltage		4.3 VDC
3.	Input Current		226 ma
4.	19 volt Bus Voltage	approximately	15 VDC
5.	Heater Time Out		125 sec

B. Reading Taken with HV Turned On*

1.	Heater Current		310 ma
2.	Heater Voltage		4.3 VDC
3.	Input Current		2.4 amps
4.	19 V Bus Voltage		15.07 VDC
5.	High Voltage Output		
	EK	approximately	-2861
	EC	approximately	-1773

*The power supply was oscillating during these readings. Input current varied from 2.3 to 2.5 amps after approximately 3 minute current stabilized at 2.44 amps, but high frequency oscillation continued (see photos).

Test data taken on HAC TWTA breadboard power supply - (Resistive Loads)

Tests conducted 16 January 1975 at Torrance facility.

Test Number 1. Initial conditions prior to component failure simulation

A. Calibration Settings

1. Input Current Trip	6.5 amps
2. Helix Current Trip	6.0 ma
3. Heater Time Out	90.5 sec

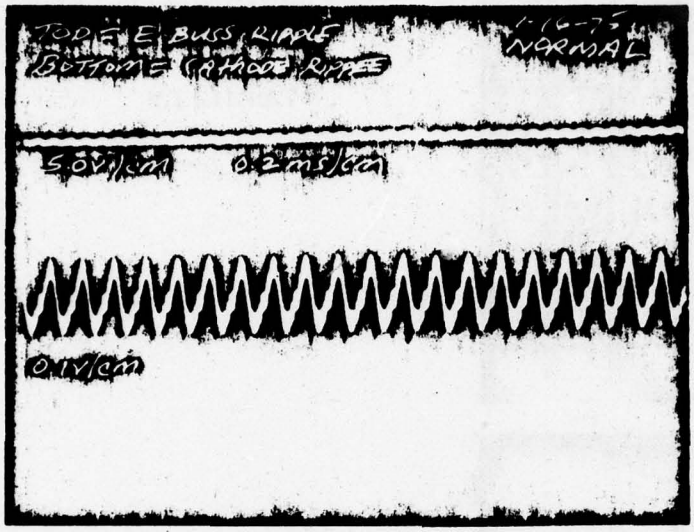
B. Nominal Operation Conditions

1. During Heater Time Out (HV Off)

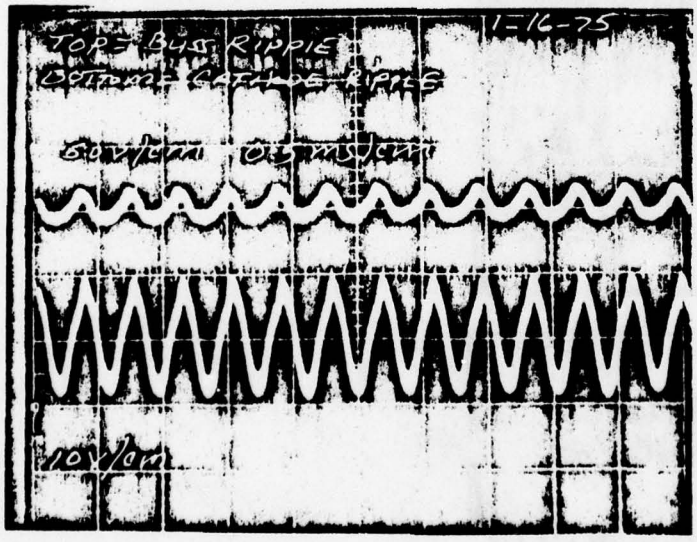
a. Heater Current	412 ma
b. Heater Voltage	5.7 volts
c. Heater Linear Regulator Output Voltage	18.84 VDC
d. Input Current	301 ma
e. 19 Volt Bus Voltage	19.86 VDC
f. Supply Voltage	32.5 VDC

2. High Voltage "ON"

a. Heater Current	412 ma
b. Heater Voltage	5.7 VDC
c. Heater Linear Regulator Output	18.84 VDC
d. Input Current	2.817 amps
e. 19 Volt Bus Voltage	19.33 VDC
f. Supply Voltage	32.0 VDC
g. High Voltage Output	
EK	-3688 VDC
IK	.5 ma
E_c	-2286
I_c	50 ma

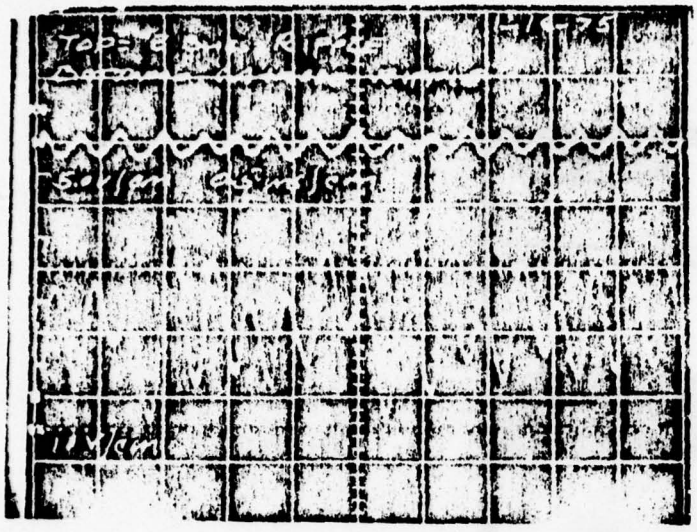


NORMAL RIPPLE VOLTAGES



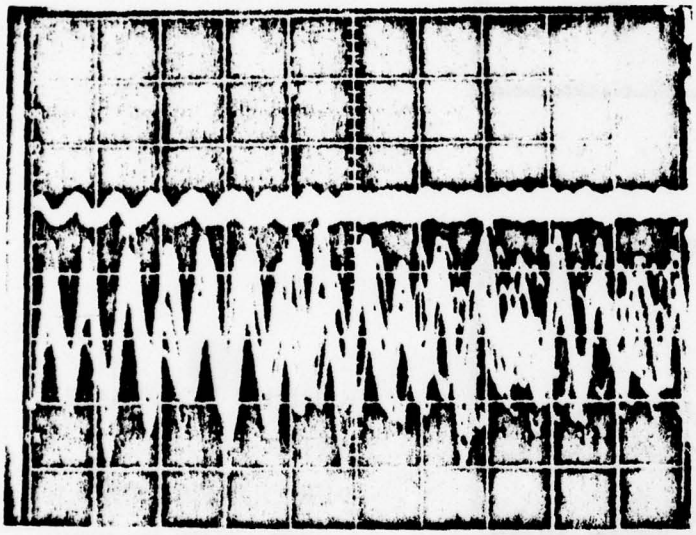
RIPPLE VOLTAGE WITH + 5 VDC DISCONNECTED AND AFTER REACHING STABLE OPERATION

+5VDC DISCONNECTED



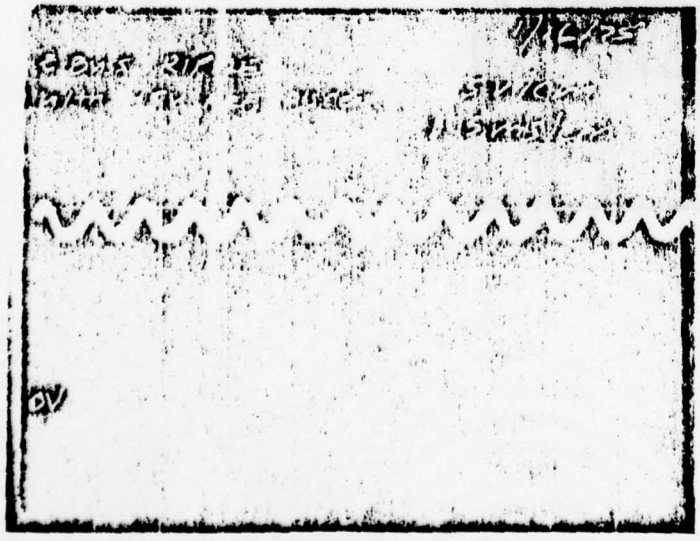
RIPPLE VOLTAGE
BEFORE
STABILITY

Single Sweep

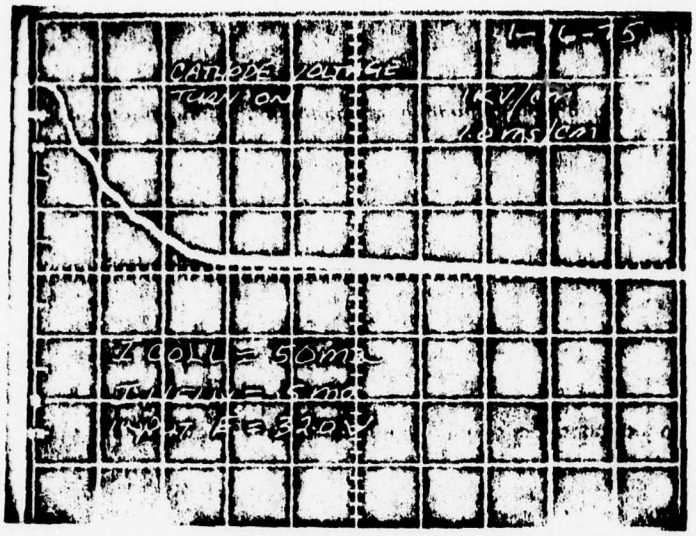


SAME AS ABOVE

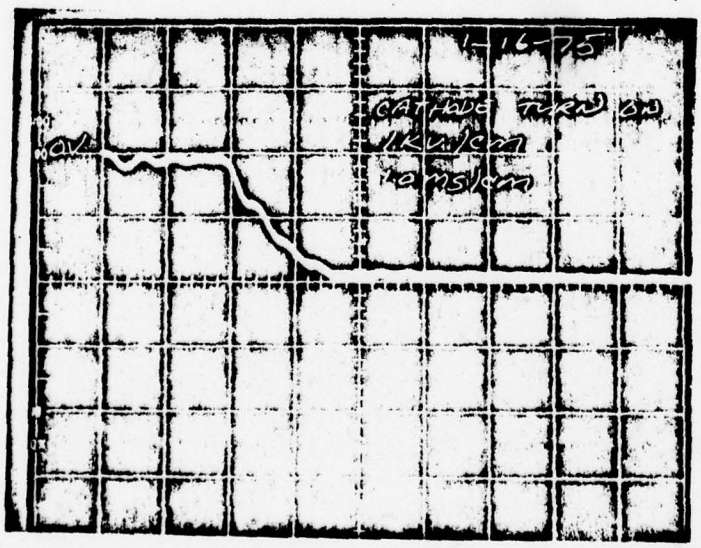
Multiple Sweep



19 VOLT BUS



NORMAL
CONFIGURATION



+ 5 VDC
DISCONNECTED

APPENDIX B-2

DATA PACKAGE; INVESTIGATION OF 777 HLTWTA
RESPONCES TO DISTURBANCES ON PRIMARY
POWER AND CONTROL VOLTAGE LINES, 13 MARCH 1975, G.E. WILLEFORD

13 March 1975

DATA PACKAGE

INVESTIGATION OF 777 HLTWTA RESPONSES TO DISTURBANCES ON PRIMARY POWER AND CONTROL VOLTAGE LINES

Prepared by: _____
G. E. Willeford, EMC 777
EM Control Department

Approved by: _____
J. A. Spagon, Manager
EM Control Department

INVESTIGATION OF 777 HLTWTA RESPONSES TO DISTURBANCES ON PRIMARY POWER AND CONTROL VOLTAGE LINES.

Background: As a portion of the on-going investigation of the 777 HLTWTA anomalies experienced on-orbit, the EM Control Department was requested by the 777 Project Office to devise a series of tests to characterize the nature, if any, of responses by the HLTWTA to abnormal disturbances on its power and control lines. The purpose was not to repeat normal EMC/EMI testing but, rather, to perform non-destructive tests at levels outside of specified tolerances. It was, therefore, first postulated that there might be undetected interruptions in either the primary power voltage or the control voltage, or both. Secondly, the occurrence of positive or negative transients on the control line was postulated since Control lines are not normally tested for spike susceptibility during EMI qualification tests. A further test objective was to determine the actual audio susceptibility characteristics of the HLTWTA. The qualification test program had merely required go/no-go testing against the published limit curve.

The HLTWTA first made available for test was the Qualification Unit (TRW S/N 13-1, Hughes S/N 19). It was decided very shortly to discontinue testing on this unit. The first test sequence, one millisecond interruptions of 28 VDC power, resulted in severe perturbations on all of the TLM outputs. Indications were that the high voltages on the tube were dropping toward zero for 25 - 40 milliseconds. It was felt that this could damage the Qualification Unit tube.

The data shown in this package was obtained using HLTWTA Model 1202H-2, TRW S/N 24-13, Hughes S/N 18. The tube had previously been removed from this unit but the power converter modules were still operational. Initial tests on S/N 24-13 showed TLM output waveforms virtually identical to those obtained with S/N 13-1.

POWER LINE INTERRUPTION TESTS

ENGINEERING NOTES ON THIS SECTION

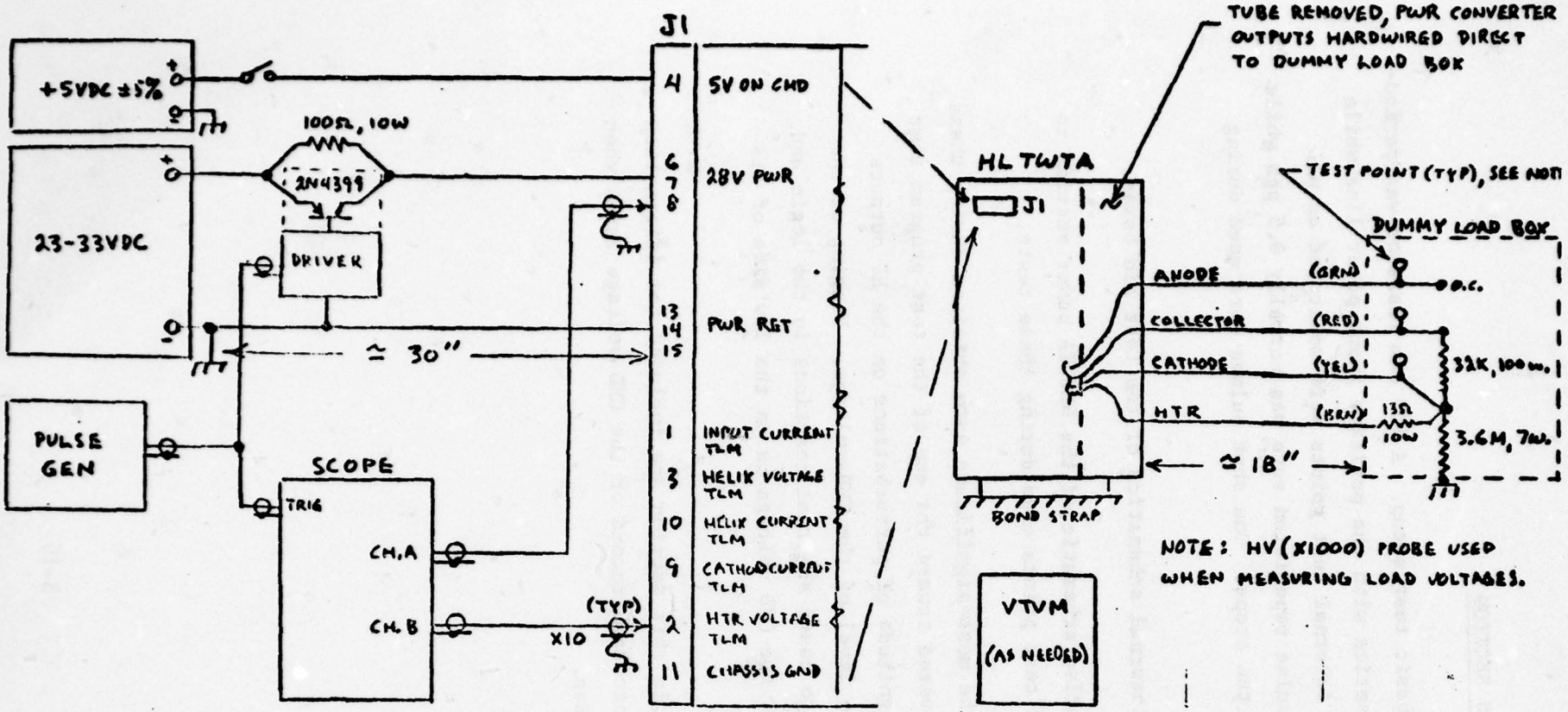
1. Figure 1 shows the basic test setup. A 100 ohm resistor was periodically switched in series with the positive input power line while various outputs and internal test points were monitored on an oscilloscope. The pulse repetition rate was normally 0.5 pps while visually monitoring the scope. One shot pulses were used during photography.

2. Figure 2 shows the internal schematics of the test aid boxes.

3. Figure 3 is a simplified schematic of the HLTWTA power section to show the location of test points used during these tests.

4. Photos 1 - 11 show the most significant data obtained during these tests. It was discovered toward the end of the test program that the existance and magnitude of perturbations on the HV outputs was a function of the level of the CMD voltage. Ringing on the SIG RTN BUS appears to cause abnormal reactions in the logic and regulator circuits if the CMD voltage is on the low side of its tolerance.

5. The remaining photos in this section are included for information only. There was no accurate record of the CMD voltage level when these photos were taken.



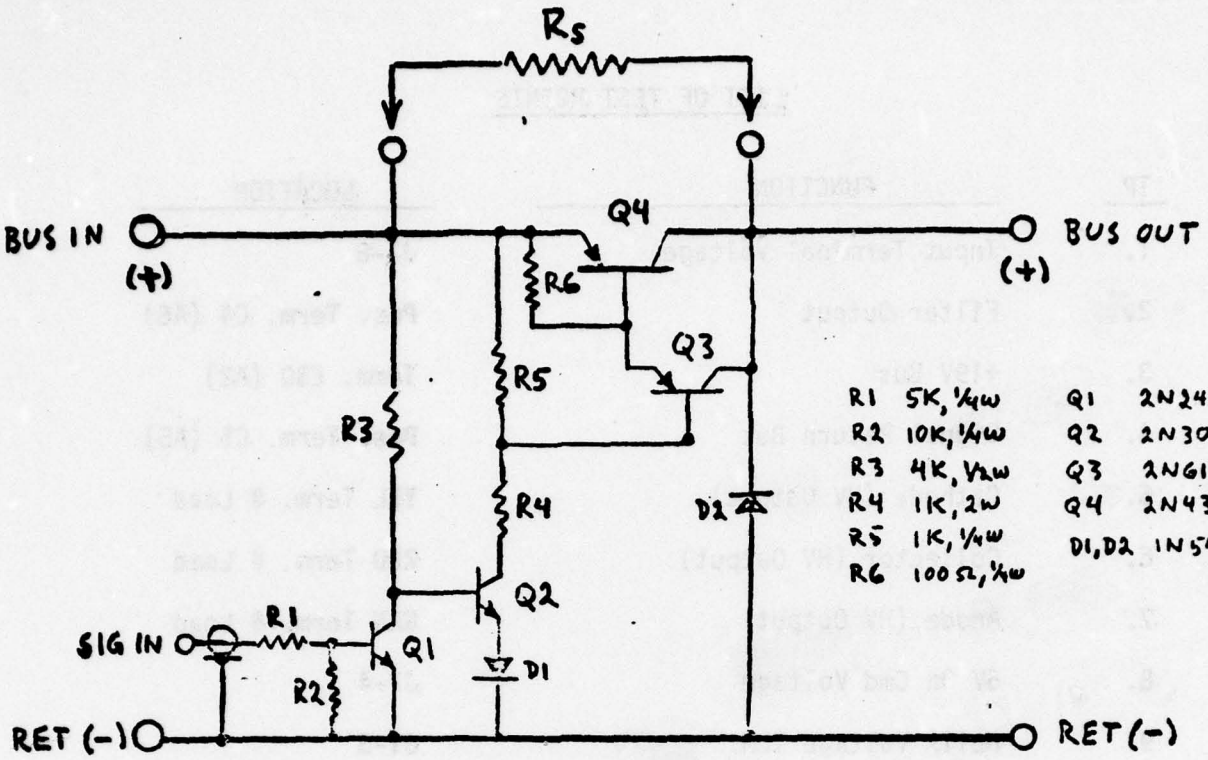
B-16

FIGURE 1

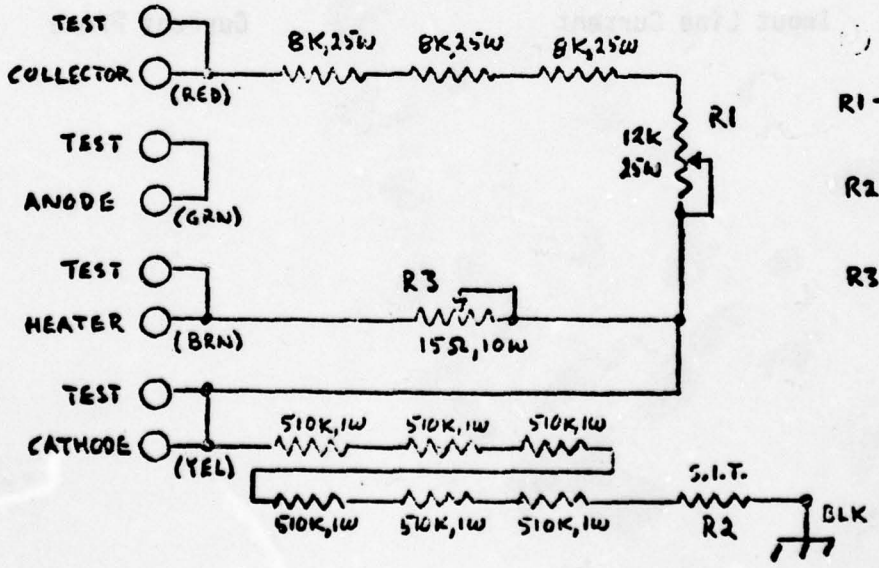
BASIC TEST SETUP - POWER LINE INTERRUPTIONS

TEST ITEM:
HLTWTA MODEL 1202H-2
TRW S/N 24-13
(HUGHES S/N 18)

TEST EQUIP:
SPECIAL TEST PNP SWITCH - TRW 12CA0029
POWER SUPPLY - HP-6289A
POWER SUPPLY - LAMBDA LMF36
PULSE GEN - HP-214A
SCOPE - TEKTRONIX 545B/1A1 (W. PG013A PROBE)
VTVM - HP-412A



CONTROLLED POWER LINE
INTERRUPT SWITCH (TRW 12CA0029)



DUMMY LOAD BOX

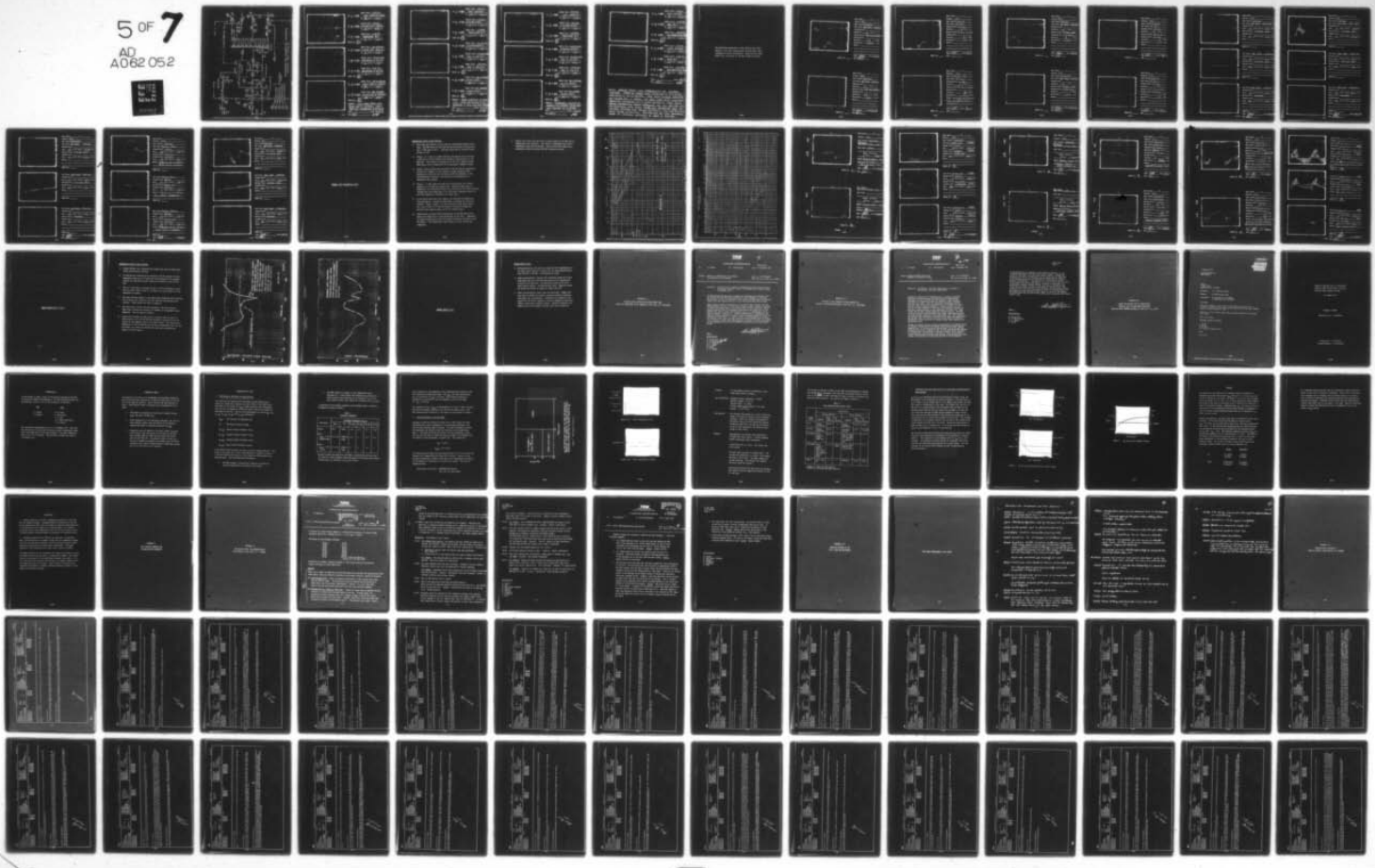
SPECIAL TEST AID BOXES FIGURE 2

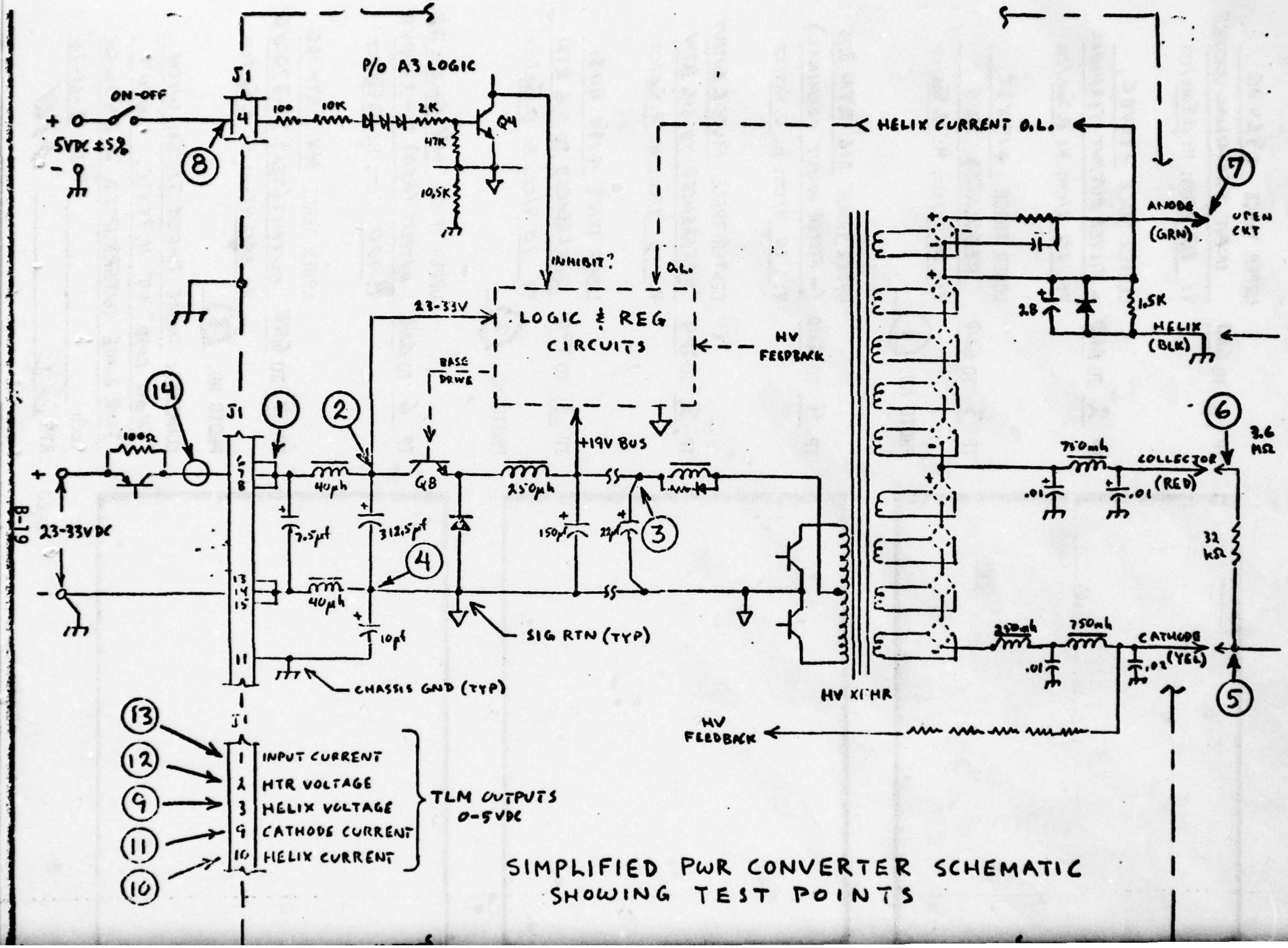
LIST OF TEST POINTS

TP	FUNCTION	LOCATION
1.	Input Terminal Voltage	J1-8
2.	Filter Output	Pos. Term. C4 (A6)
3.	+19V Bus	Term. E30 (A2)
4.	Signal Return Bus	Pos. Term. C5 (A5)
5.	Cathode (HV Output)	YEL Term. @ Load
6.	Collector (HV Output)	RED Term. @ Load
7.	Anode (HV Output)	GRN Term. @ Load
8.	5V On Cmd Voltage	J1-4
9.	Helix Voltage TLM	J1-3
10.	Helix Current TLM	J1-10
11.	Cathode Current TLM	J1-9
12.	HTR Voltage TLM	J1-2
13.	Input Current TLM	J1-1
14.	Input Line Current	Current Probe

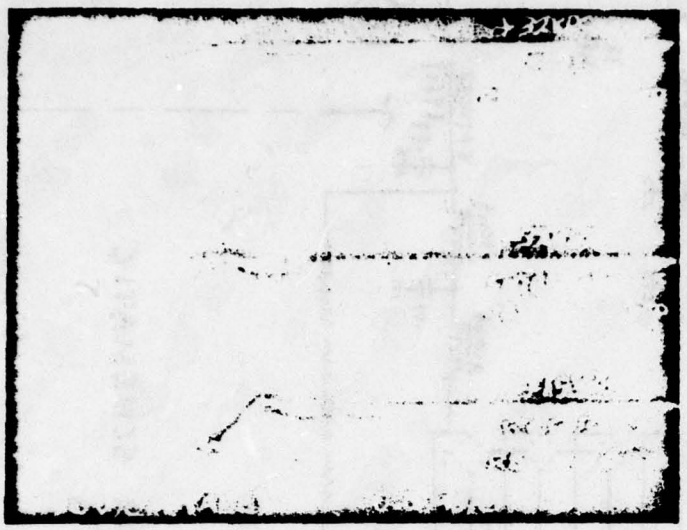
AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

5 OF 7
AD A062 052





SIMPLIFIED PWR CONVERTER SCHEMATIC
SHOWING TEST POINTS

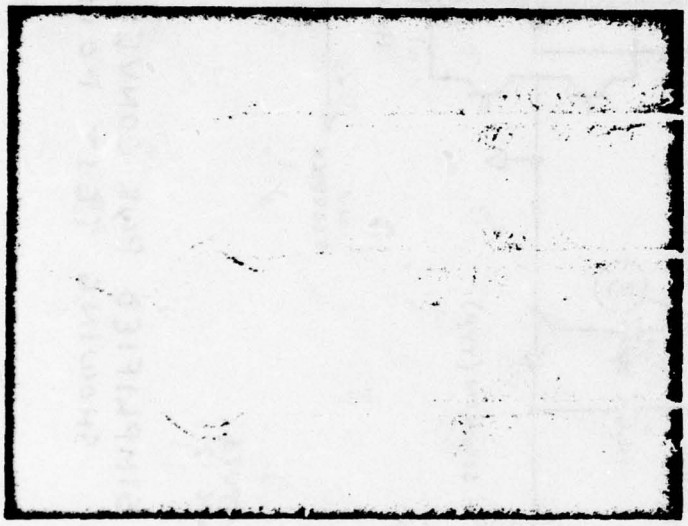


TP 1 TO GND — UPPER TRACE +32VDC INPUT TERMINAL VOLTAGE
V: 10 V/cm; H: 0.5ms/cm

TP 2 TO GND — CENTER TRACE +32VDC, + FILTER OUTPUT TERMINAL
V: 10 V/cm; H: 0.5ms/cm

TP 3 TO GND — LOWER TRACE +19VDC REGULATED BUS
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. (1)

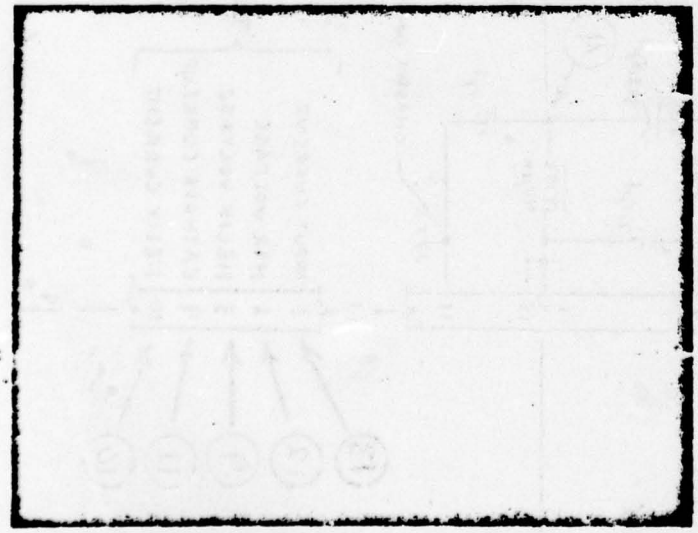


TP 4 TO GND — UPPER TRACE SIG RTN BUS (- FILTER OUTPUT TERMINAL)
V: 10 V/cm; H: 0.5ms/cm

TP 2 TO TP4 — CENTER TRACE FILTER OUTPUT REFERENCED TO SIG RTN
V: 10 V/cm; H: 0.5ms/cm

TP 3 TO TP4 — LOWER TRACE +19V BUS REFERENCED TO SIG RTN
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. (2)



TP 6 TO GND — UPPER TRACE HV COLLECTOR OUTPUT (RED) ≃ -2300VDC
V: 100 V/cm; H: 0.5ms/cm

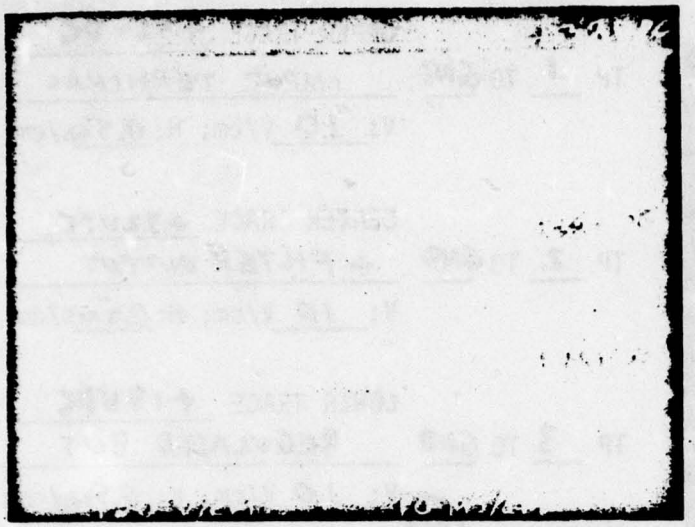
TP 5 TO GND — LOWER TRACE HV CATHODE OUTPUT (YEL) ≃ -3700VDC
V: 100 V/cm; H: 0.5ms/cm

PHOTO NO. (3)

COMMENTS: THESE PHOTOS TAKEN WITH "5V ON CMD" AT 4.75VDC. INPUT PWR LINE INTERRUPTED ≃ 650MSEC.

Tech _____ Date 3-11-75

RTE JDC

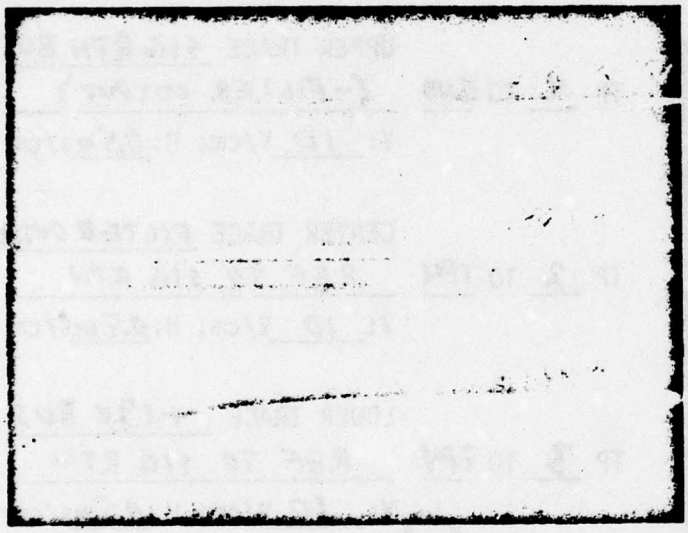


TP 1 TO GND
UPPER TRACE +32VDC INPUT TERMINAL
V: 1.0 V/cm; H: 10 ms/cm

TP 2 TO GND
CENTER TRACE +32VDC +FILTER OUTPUT
V: 1.0 V/cm; H: 10 ms/cm

TP 3 TO GND
LOWER TRACE +19VDC REGULATED BUS
V: 1.0 V/cm; H: 10 ms/cm

PHOTO NO. (4)

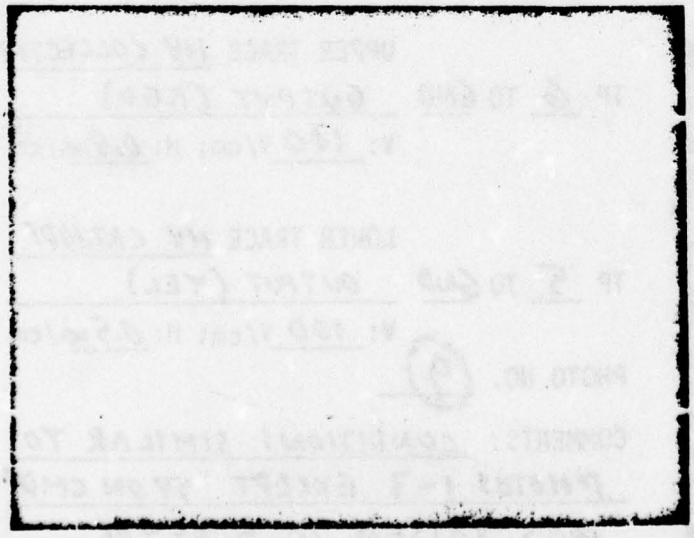


TP 4 TO GND
UPPER TRACE SIG RTN BUS (-FILTER OUTPUT)
V: 1.0 V/cm; H: 10 ms/cm

TP 2 TO TP4
CENTER TRACE +FILTER OUTPUT REF TO SIG RTN
V: 1.0 V/cm; H: 10 ms/cm

TP 3 TO TP4
LOWER TRACE +19V BUS REF TO SIG RTN
V: 1.0 V/cm; H: 10 ms/cm

PHOTO NO. (5)



TP 6 TO GND
UPPER TRACE HV COLLECTOR OUTPUT (RED)
V: 100 V/cm; H: 10 ms/cm

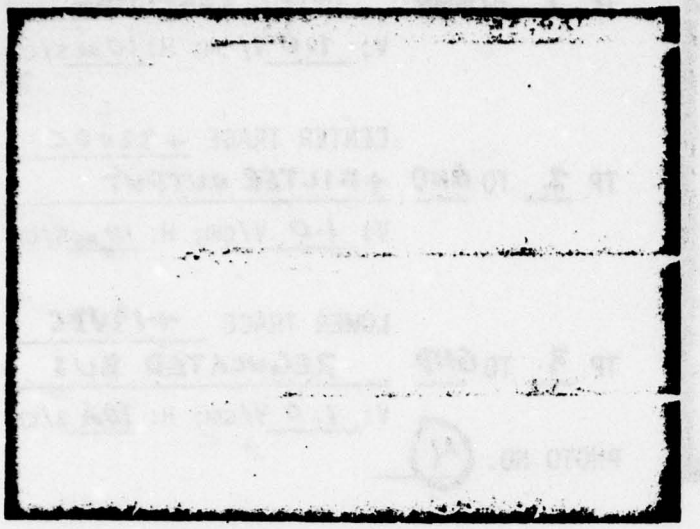
TP 5 TO GND
LOWER TRACE HV CATHODE OUTPUT (YEL)
V: 100 V/cm; H: 10 ms/cm

PHOTO NO. (6)

COMMENTS: SAME CONDITIONS AS PHOTOS 1-3. TIME AND VOLTAGE SCALES EXPANDED TO SHOW LONG TERM TRANSIE

Tech _____ Date 3-11-75

RTE FEC

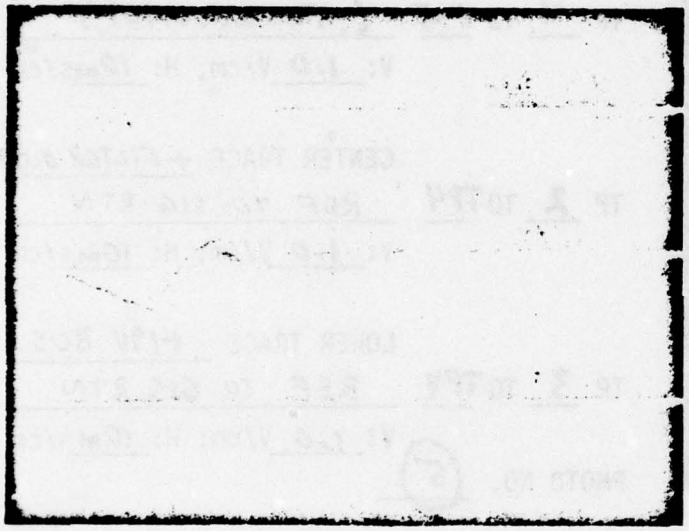


TP 1 TO GND — UPPER TRACE +32VDC INPUT TERMINAL
V: 10 V/cm; H: 0.5ms/cm

TP 2 TO GND — CENTER TRACE +32VDC, + FILTER OUTPUT
V: 10 V/cm; H: 0.5ms/cm

TP 3 TO GND — LOWER TRACE +19VDC REGULATED BUS
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. (7)

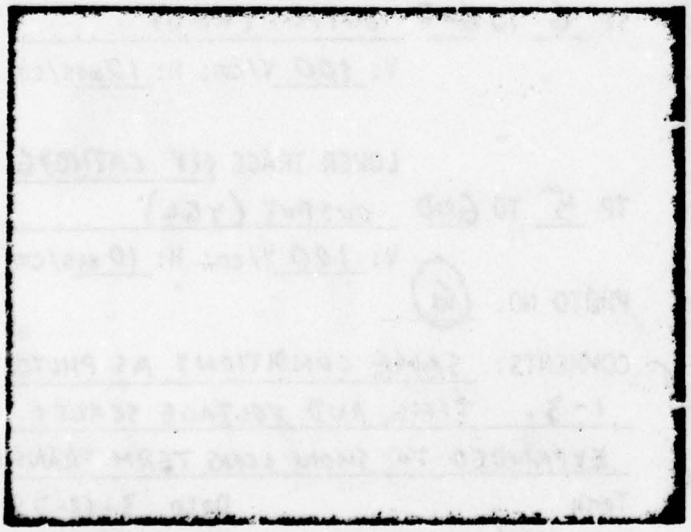


TP 4 TO GND — UPPER TRACE SIG RTN BUS (-FILTER OUTPUT)
V: 10 V/cm; H: 0.5ms/cm

TP 2 TO TP4 — CENTER TRACE FILTER OUTPUT REF TO SIG RTN
V: 10 V/cm; H: 0.5ms/cm

TP 3 TO TP4 — LOWER TRACE +19V BUS REF TO SIG RTN
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. (8)



TP 6 TO GND — UPPER TRACE HV COLLECTOR OUTPUT (RED)
V: 100 V/cm; H: 0.5ms/cm

TP 5 TO GND — LOWER TRACE HV CATHODE OUTPUT (YEL)
V: 100 V/cm; H: 0.5ms/cm

PHOTO NO. (9)

COMMENTS: CONDITIONS SIMILAR TO PHOTOS 1-3 EXCEPT "5V ON CMD" WAS RAISED TO 5.25VDC.

Tech _____ Date 3-11-75

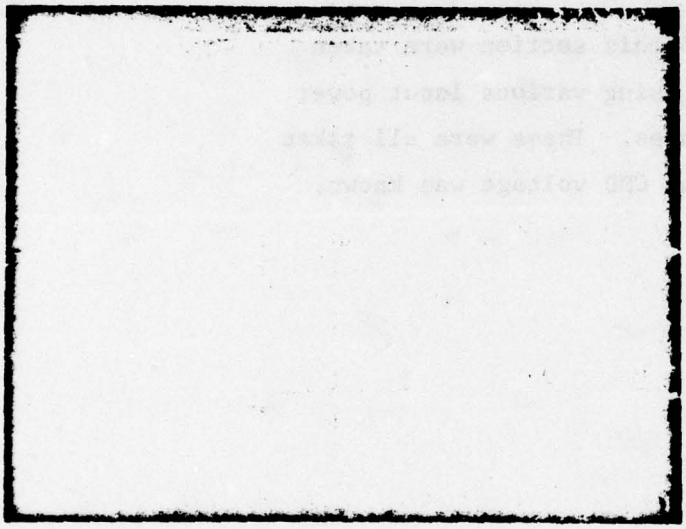
RTE HDC JFW

UPPER TRACE +32VDC
TP 1 TO GND INPUT VOLTAGE
V: 10 V/cm; H: 0.5ms/cm

CENTER TRACE +19V DC
TP 3 TO GND REG. BUS
V: 10 V/cm; H: 0.5ms/cm

LOWER TRACE SIG RTN
TP 4 TO GND BUS (NEG. FILTER TERM
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. 10



UPPER TRACE +32VDC
TP 1 TO GND INPUT VOLTAGE
V: 10 V/cm; H: 0.5ms/cm

CENTER TRACE +19V DC
TP 3 TO GND REG. BUS
V: 10 V/cm; H: 0.5ms/cm

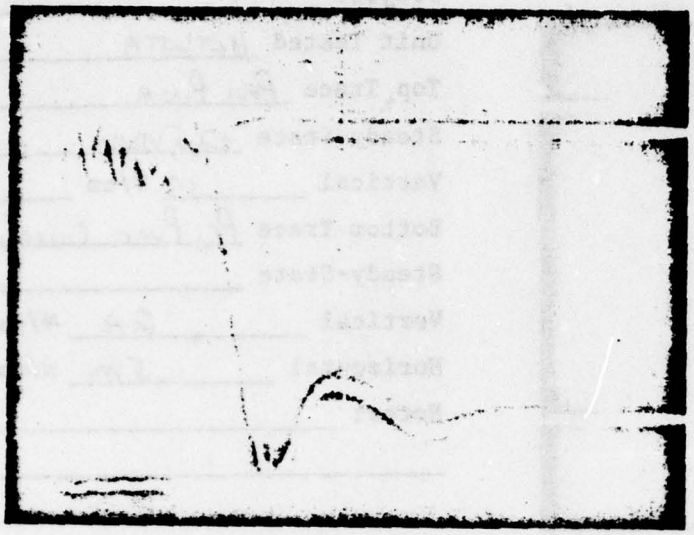
LOWER TRACE SIG RTN
TP 4 TO GND BUS (NEG. FILTER TERM
V: 10 V/cm; H: 0.5ms/cm

PHOTO NO. 11

Tech _____ Date 3/6/75
RTE 40C

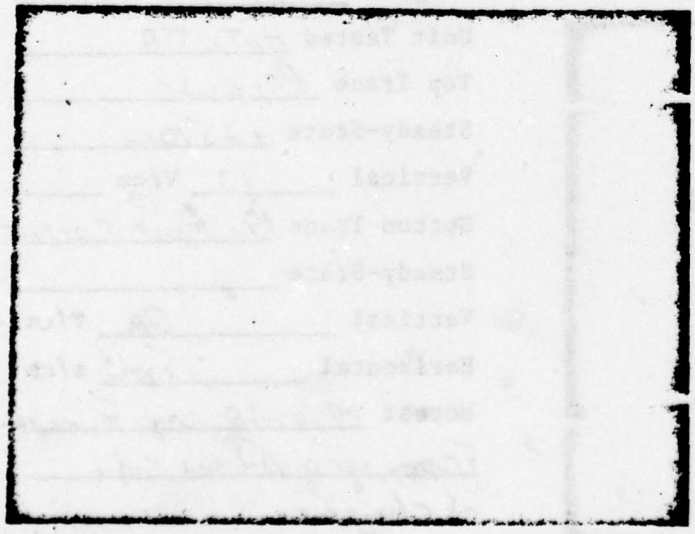
COMMENTS: EARLIER PHOTOS SHOW MARGINALITY OF CONTROL VOLTAGE. PHOTO 10 TAKEN WITH "5V ON CMD" AT ≃ 4.85VDC AND PHOTO 11 AT ≃ 5.05VDC. NOTE THAT RINGING AMPLITUDE ON SIG RTN BUS IS APPROX. THE SAME UNDER BOTH CONDITIONS. REGULATOR MAINTAINED AVG. DC OUTPUT VOLTAGE AT 19VDC DURING POWER INTERRUPTION PERIOD (850μsec), BUT WAS EXCITED INTO AN ABNORMAL MODE WHEN POWER WAS REAPPLIED AND THE CONTROL VOLTAGE WAS BELOW 5.0 VOLTS. TEST LAB PERSONNEL ALSO NOTED OCCASIONAL EXCITATION OF THIS ABNORMAL MODE AT CONTROL VOLTAGES AS HIGH AS 5.25VDC.

The following photographs in this section were taken earlier in the test program using various input power voltages and series resistances. These were all taken before the criticality of the CMD voltage was known.



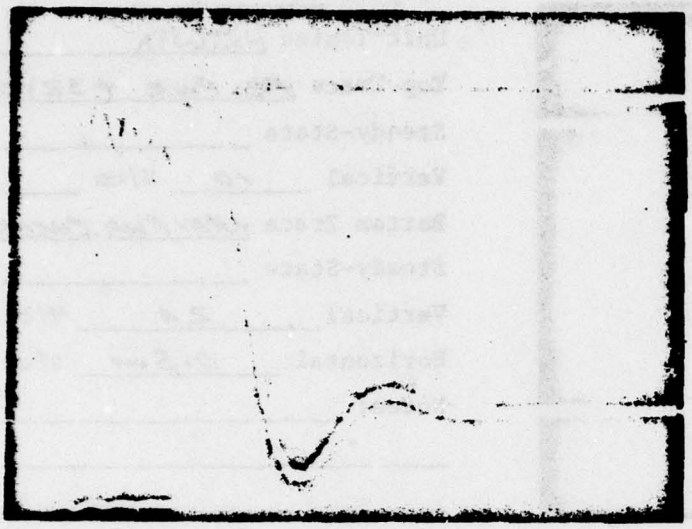
Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace PRI PWR +32VDC
Steady-State _____
Vertical 10 V/cm _____
Bottom Trace +PRI PWR CURRENT
Steady-State _____
Vertical 2A ∓/cm
Horizontal 0.5m s/cm
Notes: _____

Tech PMY Date 2-20-75
PHOTO NO. _____ RTE 40C



Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace PRI PWR +32VDC
Steady-State _____
Vertical 10 V/cm _____
Bottom Trace +PRI PWR CURRENT
Steady-State _____
Vertical 2A ∓/cm
Horizontal 5m s/cm
Notes: _____

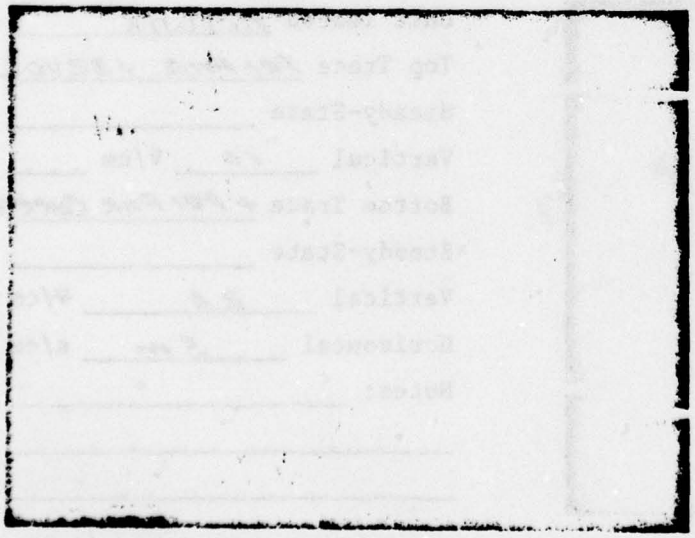
Tech PMY Date 2-20-75
PHOTO NO. _____ RTE 40C



Data Sheet _____ of _____
Project 177
Unit Tested HLTWTA
Top Trace Pri Pwr
Steady-State +25VDC
Vertical 10 V/cm
Bottom Trace Pri Pwr Current
Steady-State _____
Vertical 2A A/cm
Horizontal .5m s/cm
Notes: _____

Tech _____ Date 4MAR75

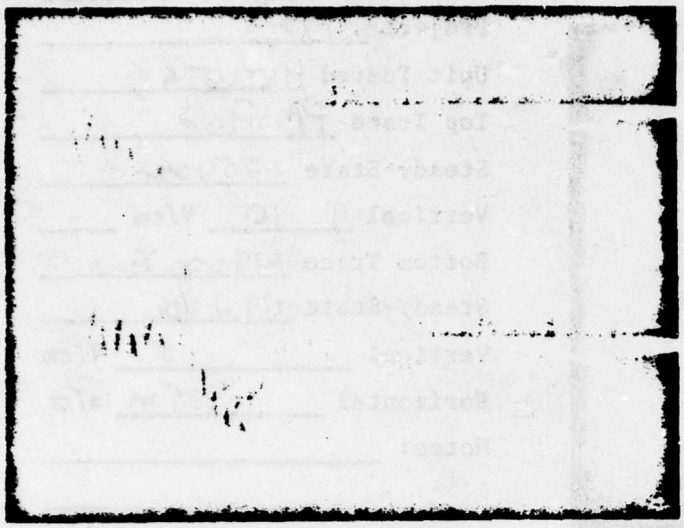
PHOTO NO. _____ RTE _____



Data Sheet _____ of _____
Project 177
Unit Tested HLTWTA
Top Trace Pri Pwr
Steady-State +25VDC
Vertical 10 V/cm
Bottom Trace Pri Pwr Current
Steady-State _____
Vertical 2A A/cm
Horizontal .5m s/cm
Notes: w/ground cap removed from ground on side of chassis

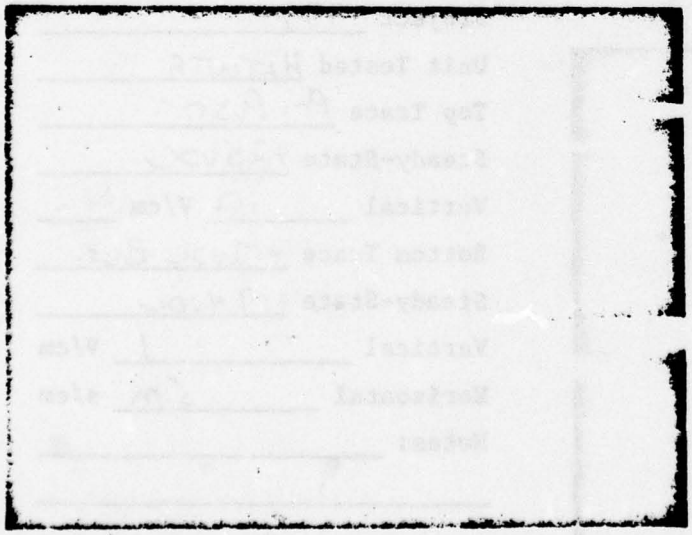
Tech _____ Date 4MAR75

PHOTO NO. _____ RTE _____



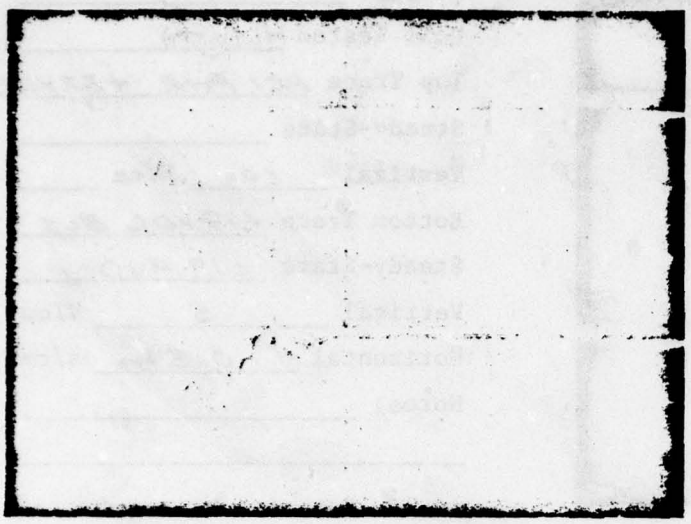
Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace PRI PWR +32VDC
Steady-State _____
Vertical 10 V/cm
Bottom Trace +19VDC BUS
Steady-State +19.4VDC
Vertical 5 V/cm
Horizontal 0.5m s/cm
Notes: _____

Tech PMY Date 2-20-75
PHOTO NO. _____ RTE 50C



Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace PRI PWR +32VDC
Steady-State _____
Vertical 10 V/cm
Bottom Trace +19VDC BUS
Steady-State +19.4VDC
Vertical 1 V/cm
Horizontal 5m s/cm
Notes: _____

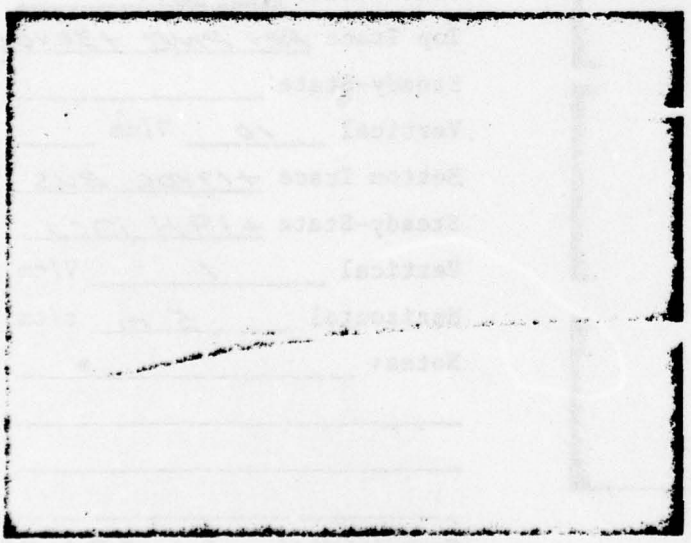
Tech PMY Date 2-20-75
PHOTO NO. _____ RTE 50C



Data Sheet _____ of _____
Project 777
Unit Tested HATWTA
Top Trace Pr. Pwr
Steady-State +25VDC
Vertical 10 V/cm
Bottom Trace +19VDC Bus
Steady-State +19.4 VDC
Vertical 5 V/cm
Horizontal .5m s/cm
Notes: _____

Tech [signature] Date 4MAR75

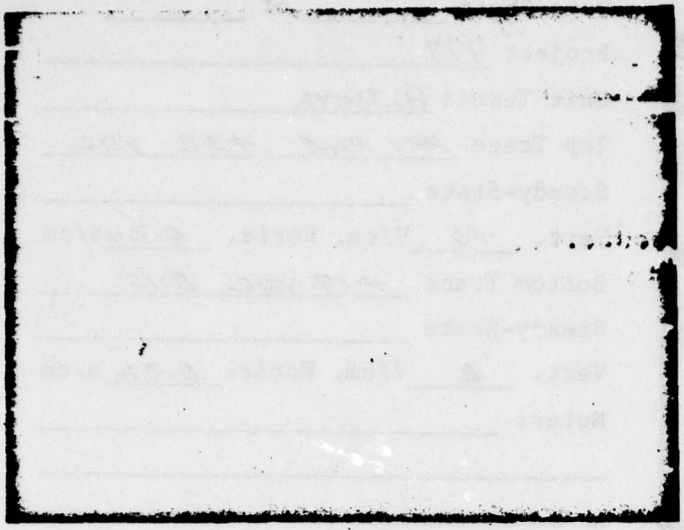
PHOTO NO. _____ RTE _____



Data Sheet _____ of _____
Project 777
Unit Tested HATWTA
Top Trace Pr. Pwr
Steady-State +25VDC
Vertical 10 V/cm
Bottom Trace +19VDC Bus
Steady-State +19.4VDC
Vertical 1 V/cm
Horizontal 5m s/cm
Notes: _____

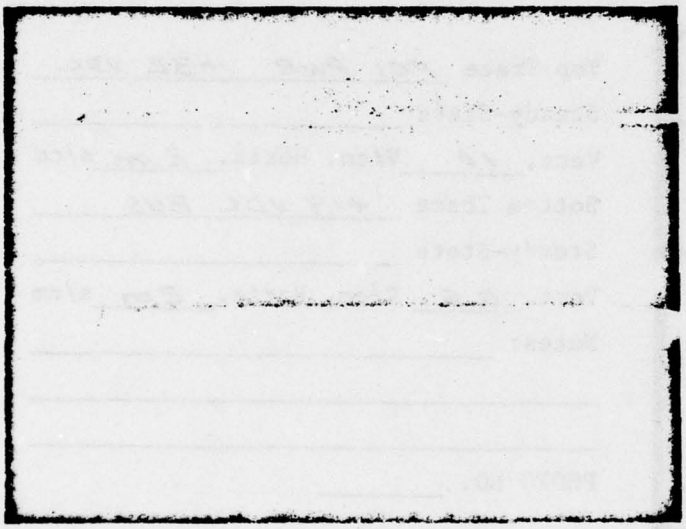
Tech [signature] Date 4MAR75

PHOTO NO. _____ RTE _____



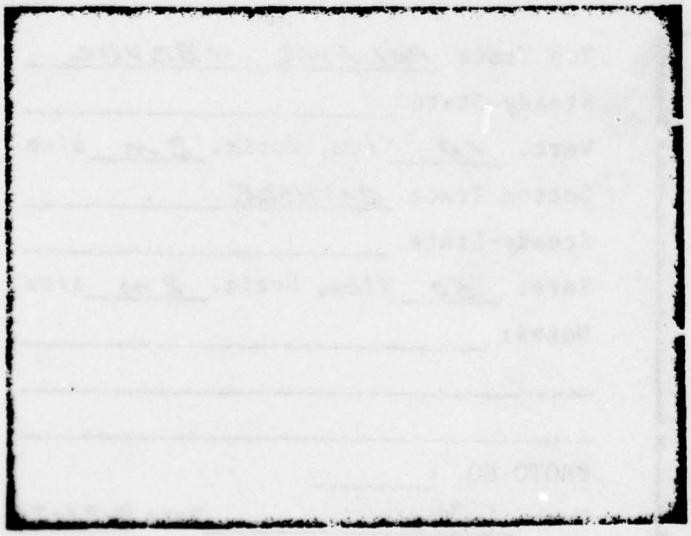
Data Sheet _____ of _____
Project 777
Unit Tested HLTWSTA
Top Trace PRI PWR +32 VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 0.2 s/cm
Bottom Trace +19 VDC BUS
Steady-State _____
Vert. 2 V/cm, Horiz. 0.2 s/cm
Notes: _____

PHOTO NO. _____



Top Trace PRI PWR +32 VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 2m s/cm
Bottom Trace +19 VDC BUS
Steady-State _____
Vert. 0.5 V/cm, Horiz. 2m s/cm
Notes: _____

PHOTO NO. _____

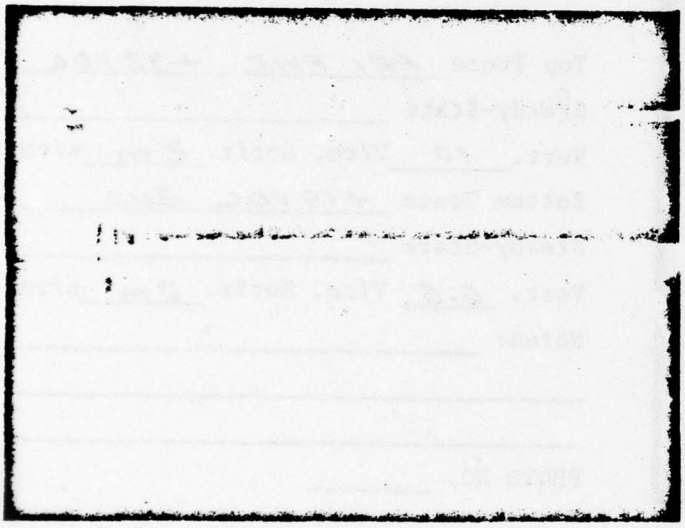


Top Trace PRI PWR +32 VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 2m s/cm
Bottom Trace CATHODE
Steady-State _____
Vert. 50 V/cm, Horiz. 2m s/cm
Notes: _____

PHOTO NO. _____
Tech PMY Date 2-21-75
RTE [illegible]

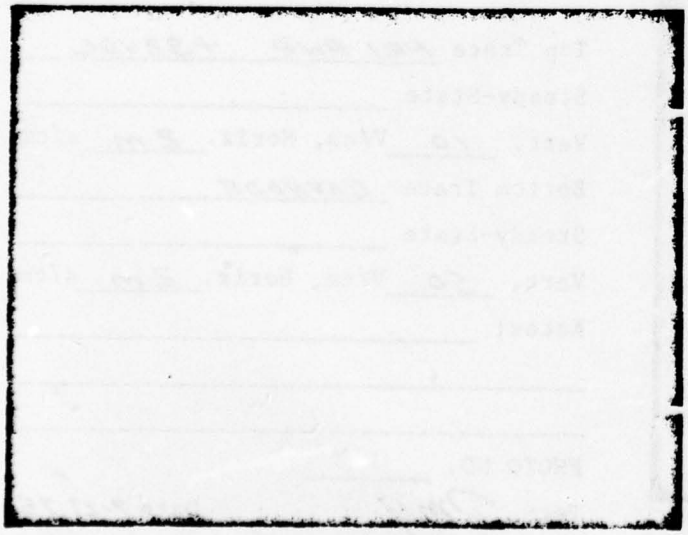
Data Sheet _____ of _____
Project 777
Unit Tested HLTUSTA
Top Trace PRI PWR +32 VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 0.2ms/cm
Bottom Trace +19 VDC BUS
Steady-State _____
Vert. 2 V/cm, Horiz. 0.2m s/cm
Notes: _____

PHOTO NO. _____



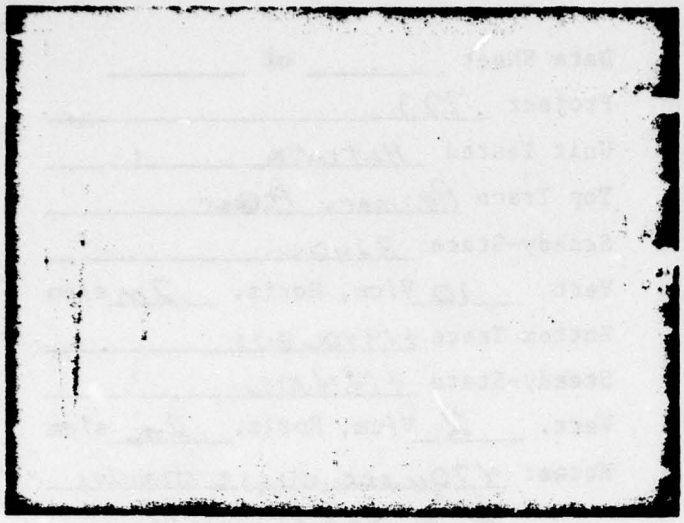
Top Trace PRI PWR +32 VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 2 m s/cm
Bottom Trace +19 VDC BUS
Steady-State _____
Vert. 0.5 V/cm, Horiz. 2m s/cm
Notes: _____

PHOTO NO. _____



Top Trace PRI PWR +32VDC
Steady-State _____
Vert. 10 V/cm, Horiz. 2m s/cm
Bottom Trace CATHODE
Steady-State _____
Vert. 50 V/cm, Horiz. 2m s/cm
Notes: _____

PHOTO NO. _____
Tech PMY Date 2-21-75
RTE TDC



Data Sheet _____ of _____

Project 777

Unit Tested HLTUSTA

Top Trace PRI PWR +32 VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 0.2m s/cm

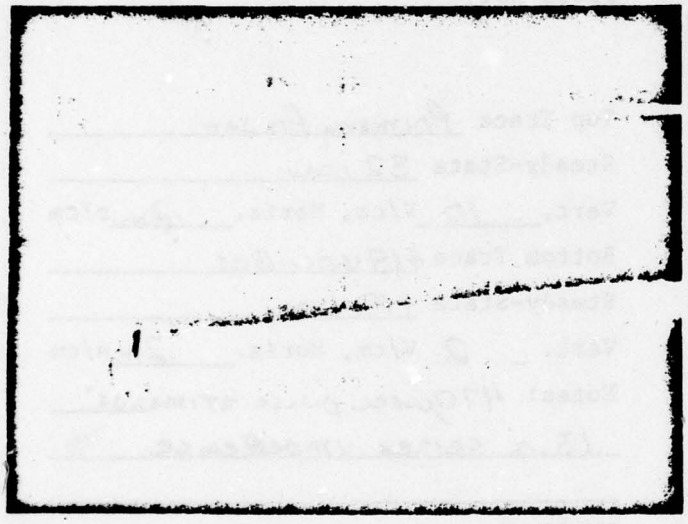
Bottom Trace +19 VDC BUS

Steady-State _____

Vert. 2 V/cm, Horiz. 0.2m s/cm

Notes: _____

PHOTO NO. _____



Top Trace PRI PWR +32 VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 2m s/cm

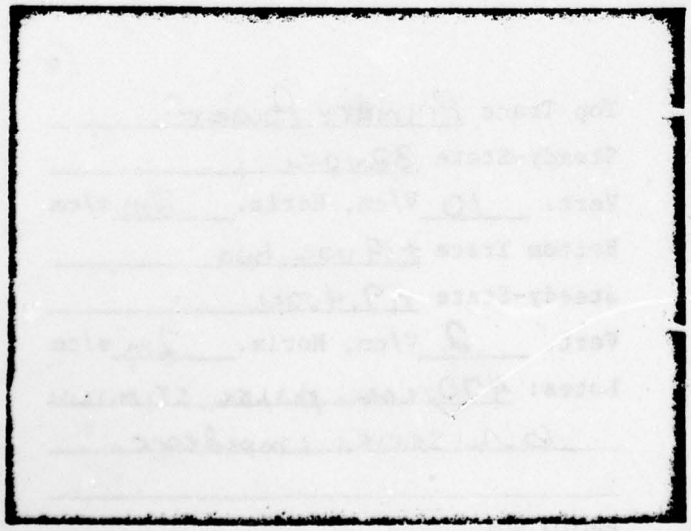
Bottom Trace +19 VDC BUS

Steady-State _____

Vert. 0.5 V/cm, Horiz. 2m s/cm

Notes: _____

PHOTO NO. _____



Top Trace PRI PWR +32 VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 2m s/cm

Bottom Trace CATHODE

Steady-State _____

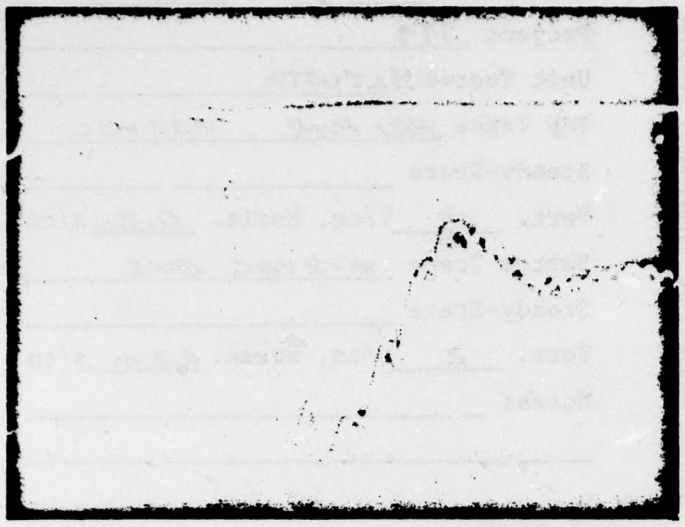
Vert. 50 V/cm, Horiz. 2m s/cm

Notes: _____

PHOTO NO. _____

Tech _____ Date 2-2-79

RTE _____



Data Sheet _____ of _____

Project 777

Unit Tested HLTWTA

Top Trace Primary Power

Steady-State 32VDC

Vert. 10 V/cm, Horiz. .2m s/cm

Bottom Trace +19VDC BUS

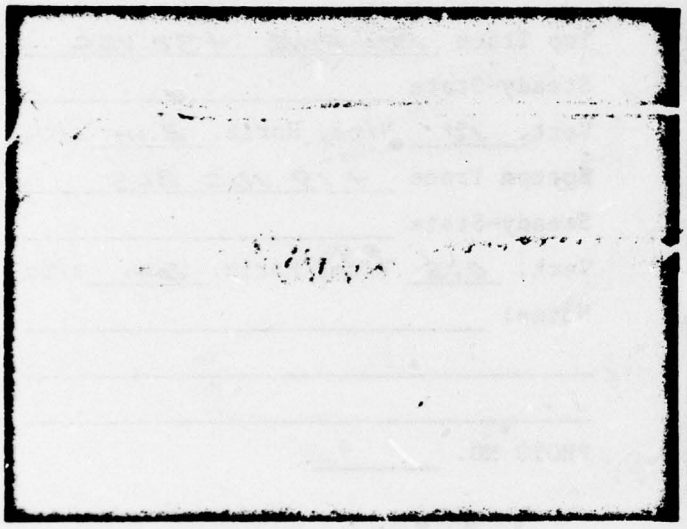
Steady-State +19.4VDC

Vert. 2 V/cm, Horiz. .2m s/cm

Notes: 470μsec pulse stimulus

3Ω series impedence

PHOTO NO. _____



Top Trace Primary Power

Steady-State 32VDC

Vert. 10 V/cm, Horiz. .2m s/cm

Bottom Trace +19VDC BUS

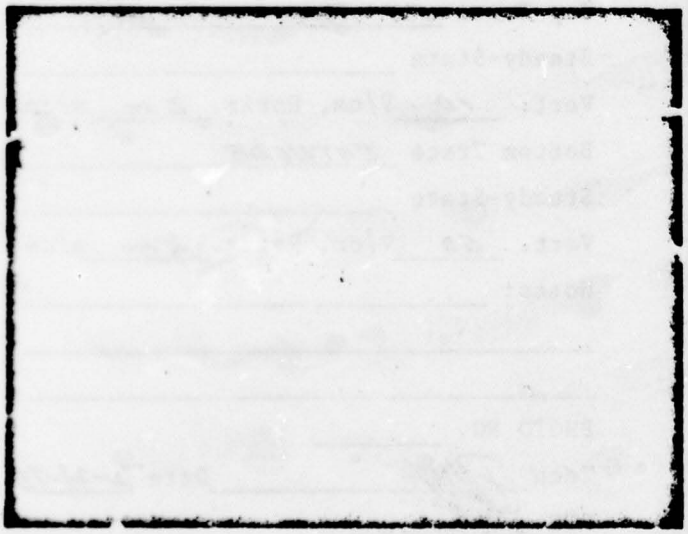
Steady-State +19.4VDC

Vert. 2 V/cm, Horiz. .2m s/cm

Notes: 470μsec pulse stimulus

13Ω series impedence

PHOTO NO. _____



Top Trace Primary Power

Steady-State 32VDC

Vert. 10 V/cm, Horiz. .2m s/cm

Bottom Trace +19VDC BUS

Steady-State +19.4VDC

Vert. 2 V/cm, Horiz. .2m s/cm

Notes: 470μsec pulse stimulus

6Ω series impedence.

PHOTO NO. _____

Tech [signature] Date 24Feb75

RTE

Data Sheet _____ of _____

Project 777

Unit Tested HLTWTA

Top Trace PRI PWR +32VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 0.2m s/cm

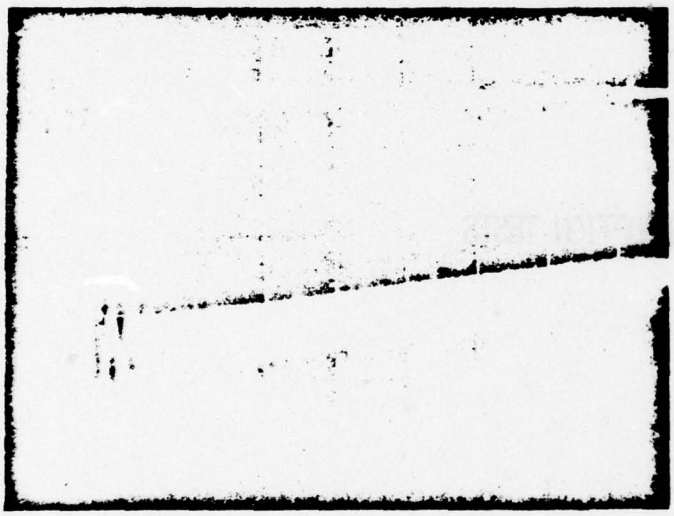
Bottom Trace +19 VDC BUS

Steady-State _____

Vert. 2 V/cm, Horiz. 0.2 s/cm

Notes: _____

PHOTO NO. _____



Top Trace PRI PWR +32VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 2m s/cm

Bottom Trace +19VDC BUS

Steady-State _____

Vert. 0.5 V/cm, Horiz. 2m s/cm

Notes: _____

PHOTO NO. _____

Top Trace PRI PWR +32 VDC

Steady-State _____

Vert. 10 V/cm, Horiz. 2m s/cm

Bottom Trace CATHODE

Steady-State _____

Vert. 50 V/cm, Horiz. 2m s/cm

Notes: _____

PHOTO NO. _____

Tech PMY Date 2-21-75

RTE ADC

CONTROL LINE INTERRUPTION TESTS

ENGINEERING NOTES ON THIS SECTION

1. Test setup was similar to that used for interrupting primary power line. The PNP switch in the test aid box was placed in series with the + 5 VDC line to J1-4. Initially there was no resistor placed across the PNP.

2. Figure 1 is a copy of a graph obtained from Hughes which indicates a roll-off in the HV outputs with repetitive interruptions of the CMD line. The ordinate is assumed to be the 0-5 V "Helix Voltage TLM" output (J1-3) translated into an equivalent CATHODE voltage.

3. Figure 2 shows similar data obtained by TRW (EM Control Department) on S/N 24-13 (Hughes S/N 18) using an average reading DC VTVM. Calibration curves for this TLM output were not available to the test personnel; therefore, the data was not translated to an equivalent high voltage.

4. Photos 1 - 9 were taken with CMD line interruptions of 1.0 milliseconds at a 10 pulse per second rate. They show that there is essentially no correlation between the waveforms on the actual internal voltages and those appearing at the TLM output terminals, which are the only diagnostics available on a flight unit.

5. At the pulse repetition rate chosen, the waveforms are apparently non-overlapping. Average DC measurement techniques are therefore invalid. Figure 1 shows a 1.2 volt roll-off, while scope photos no. 1 and 3 show a 2.2 volt excursion on the Helix Voltage TLM and 550 volts, peak-to-peak, on the HV cathode output.

6. These photos also show that interruptions of the CMD line do not need to be repetitive to cause defocusing of the Helix. Aperiodic or random interruptions will each cause a momentary decrease in the HV outputs. Tube degradation could result if these effects are cumulative.

7. **Photos 10-14 show that the effect is most severe if the CMD line is momentarily open circuited. The effect is negligible with series resistances less than 90 kilohms. These photos were taken with a resistance decade box across the PNP interruptor switch.**

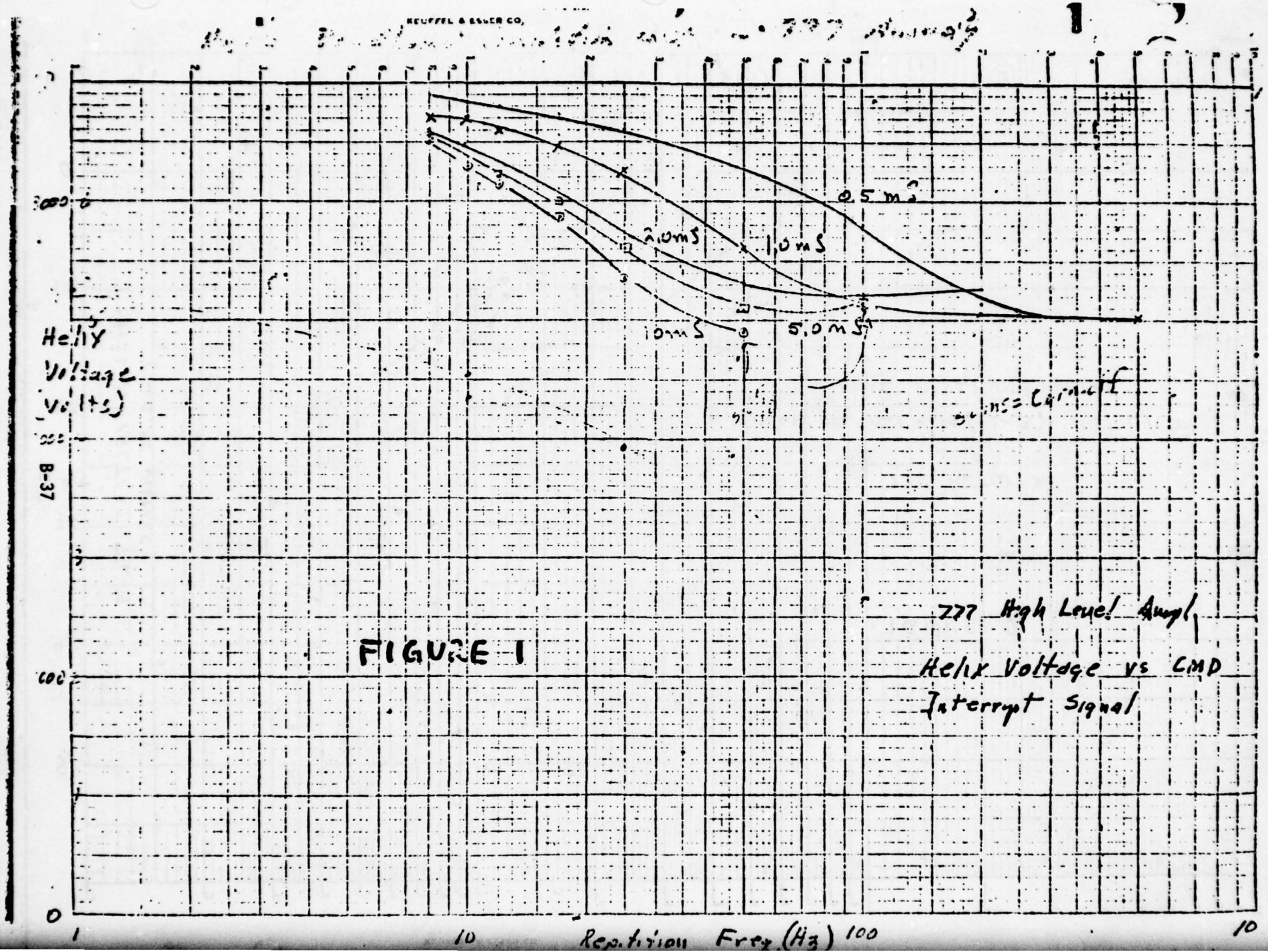
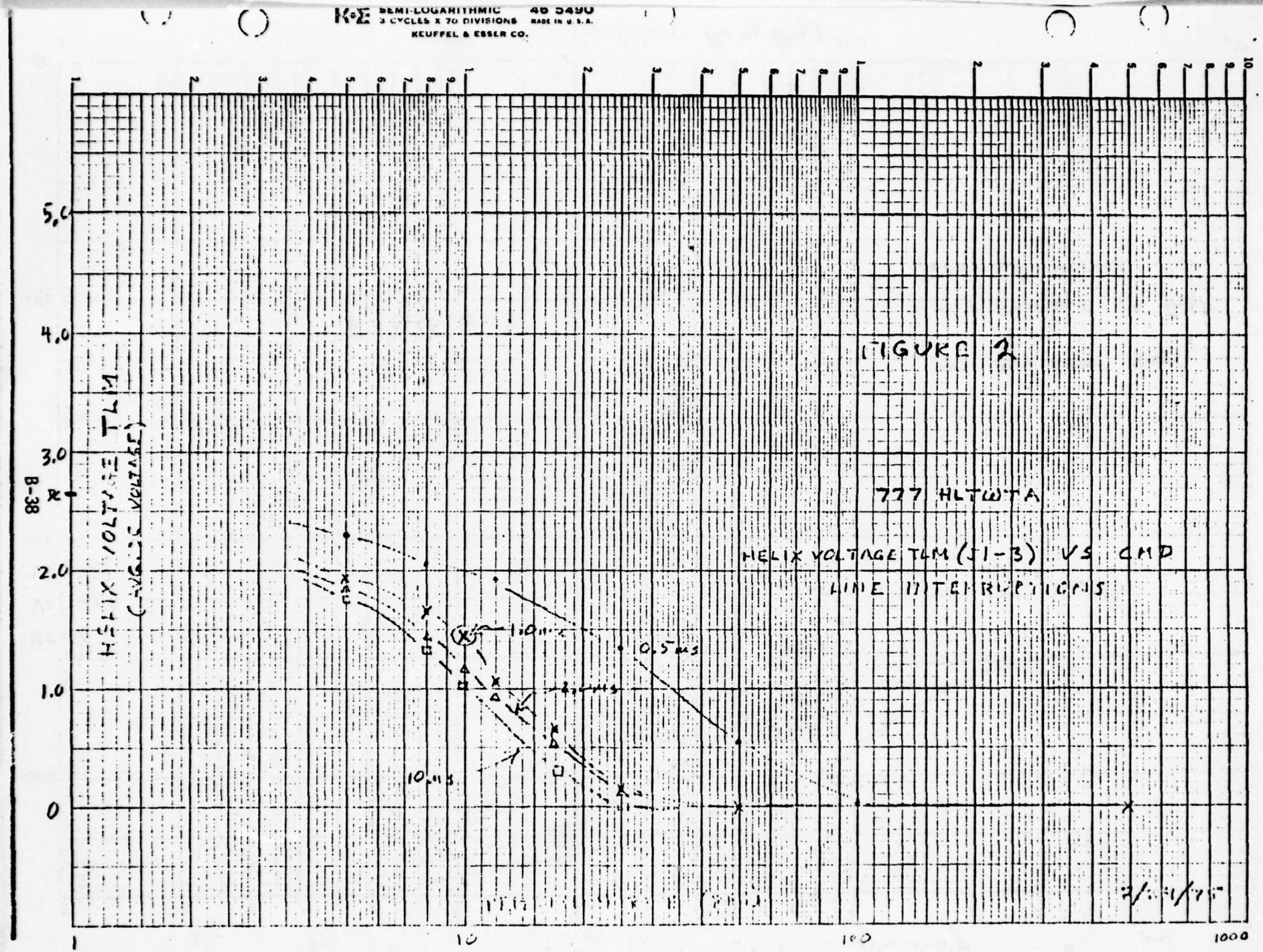
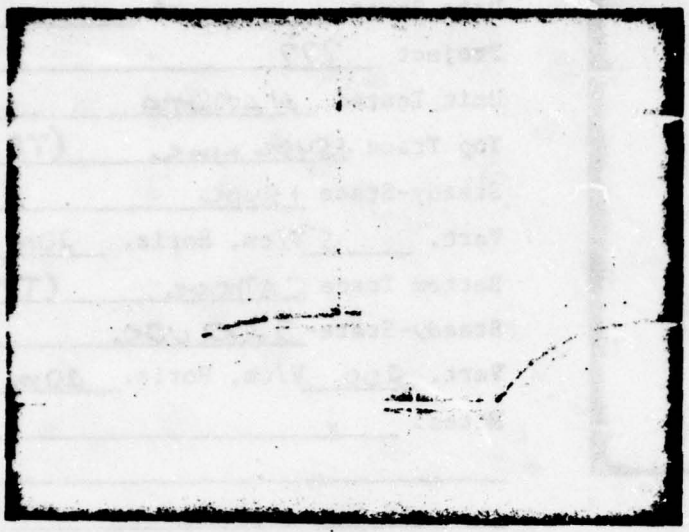

KEUFFEL & ESSER CO.
0.5 mS
1.0 mS
2.0 mS
5.0 mS
10 mS
Helix Voltage (Volts)
3000
1000
0
1
10
100
Repetition Freq. (Hz)
B-37
777 High Level Ampl.
Helix Voltage vs CMD Interrupt Signal

FIGURE 1


K+E SEMI-LOGARITHMIC 46 5490
3 CYCLES X 70 DIVISIONS MADE IN U.S.A.
KEUFFEL & ESSER CO.
HELIX VOLTAGE TLM
(CYCLIC VOLTAGE)
B-38
5.0
4.0
3.0
2.0
1.0
0
1
10
100
1000
FIGURE 2
777 HLTWTA
HELIX VOLTAGE TLM (J1-3) VS CMD
LINE INTERRUPTIONS
1.0 MS
0.5 MS
10 MS



Data Sheet ____ of ____

Project 777

Unit Tested HLTWTA

~~Test Point~~ TOPTRACE +5VDC LINE

Test Desc. +5VDC

Scope Settings

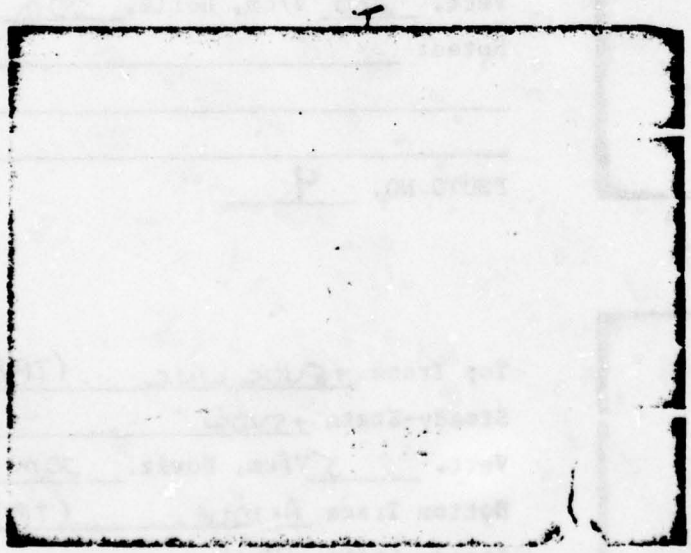
5 V/CM 20MS/CM

NOTES: BOTTOM TRACE, JL3 VERTICAL = 2V/CM HELIX VOLTAGE TLM

Tech CLS Date 24Feb75

RTE HEC

PHOTO NO. 1



~~Test Point~~ TOP TRACE +5VDC LINE

Test Desc.

Scope Settings

5 V/CM 20MS/CM

NOTES: BOTTOM TRACE, -19VDC LINE

VERTICAL 10 V/CM

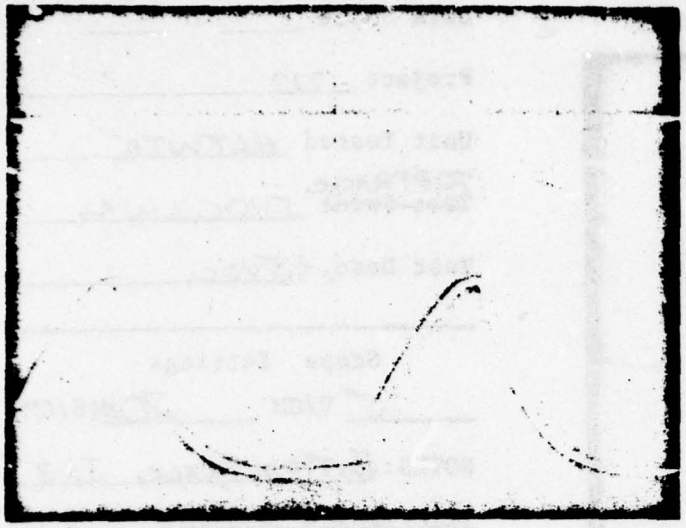
Tech CLS Date 24Feb75

RTE HEC

PHOTO NO. 2

FIGURE

B-39



Data Sheet _____ of _____

Project 777

Unit Tested HLTWTA

Top Trace +5VDC LINE (TP8)

Steady-State +5VDC

Vert. 5 V/cm, Horiz. 20m s/cm

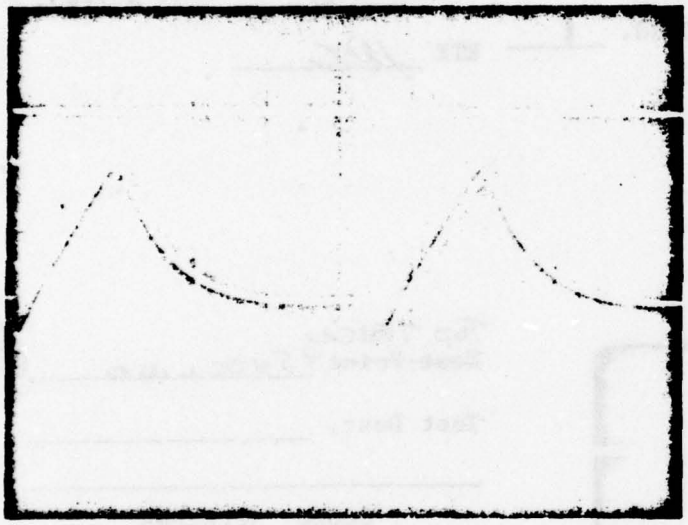
Bottom Trace CATHODE (TP5)

Steady-State -3700 VDC

Vert. 200 V/cm, Horiz. 20m s/cm

Notes: _____

PHOTO NO. 3



Top Trace +5VDC LINE (TP8)

Steady-State +5VDC

Vert. 5 V/cm, Horiz. 20m s/cm

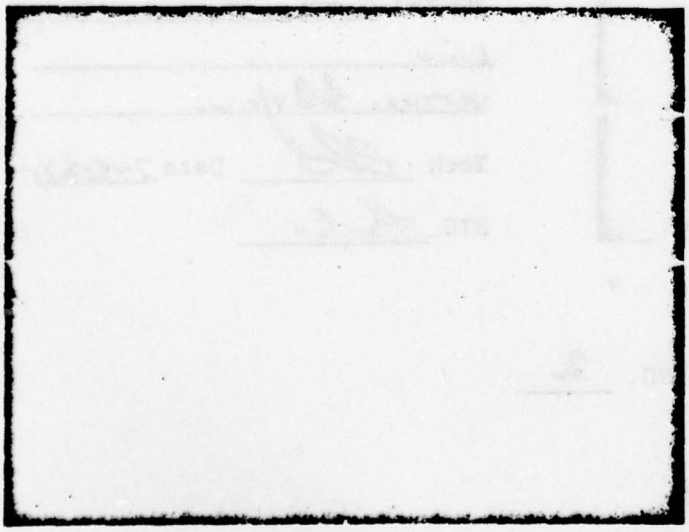
Bottom Trace COLLECTOR

Steady-State -2300VDC (TP6)

Vert. 200 V/cm, Horiz. 20m s/cm

Notes: _____

PHOTO NO. 4



Top Trace +5VDC LINE (TP8)

Steady-State +5VDC

Vert. 5 V/cm, Horiz. 20m s/cm

Bottom Trace ANODE (TP7)

Steady-State +77VDC

Vert. 20 V/cm, Horiz. 20m s/cm

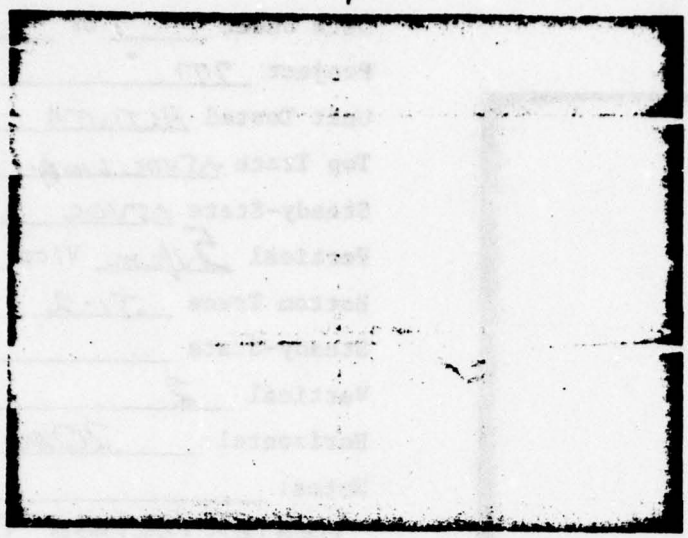
Notes: _____

PHOTO NO. 5

Tech CLS Date 24 Feb 75

RTE 40C

T



TP 8

TP 13

Data Sheet ____ of ____

Project 777

Unit Tested HELIOTA

~~Test Point~~ Top TRACE +5 VDC LINE

Test Desc. _____

Scope Settings

5 V/CM 20 MS/CM

NOTES: BOTTOM TRACE J1-1

VERTICAL 2V/CM

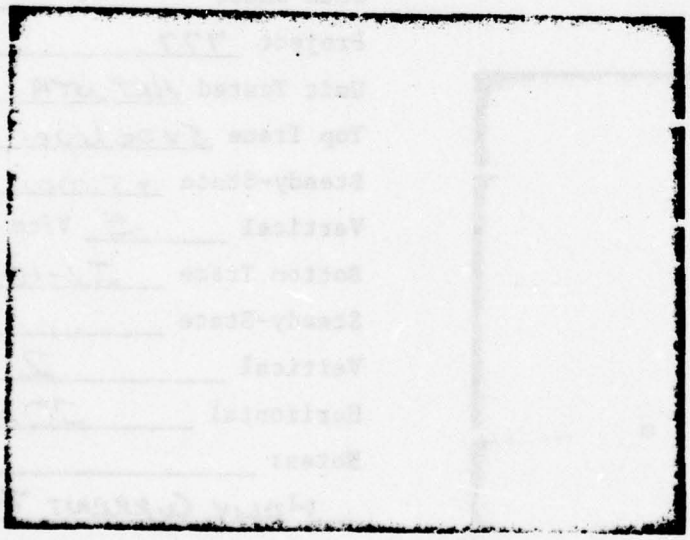
INPUT CURRENT TLM

Tech CRS Date 24 Feb 75

PHOTO NO. 6

RTE 1 2 C

T



TP 8

TP 11

~~Test Point~~ Top TRACE +5 VDC LINE

Test Desc. _____

Scope Settings

5 V/CM 20m S/CM

NOTES: BOTTOM TRACE, J1-9

VERTICAL = 2V/CM

CATHODE CURRENT TLM

Tech CRS Date 24 Feb 75

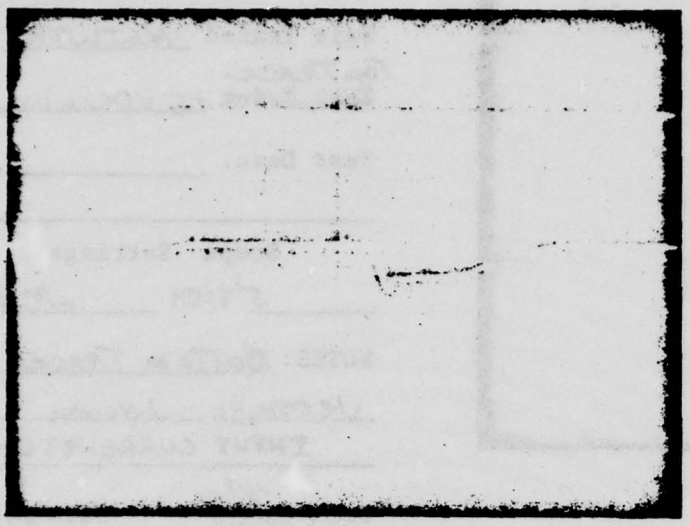
RTE 1 2 C

PHOTO NO. 7

FIGURE

B-41

T



TP 8

TP 12

Data Sheet ____ of ____

Project 777

Unit Tested HLTWTA

Top Trace +5VDC Line

Steady-State +5VDC

Vertical 5V/cm V/cm ____

Bottom Trace J1-2

Steady-State ____

Vertical 2 V/cm

Horizontal 20m s/cm

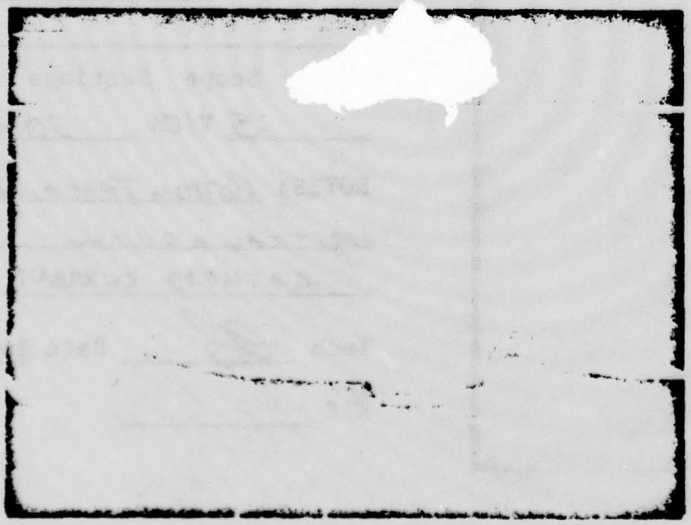
Notes: ____

HEATER VOLTAGE TLM

Tech [illegible] Date 24Feb75

PHOTO NO. 8 RTE [illegible]

T



TP 8

TP 10

Data Sheet ____ of ____

Project 777

Unit Tested HLTWTA

Top Trace 5VDC LINE

Steady-State +5VDC

Vertical 5 V/cm ____

Bottom Trace J1-10

Steady-State ____

Vertical 2 V/cm

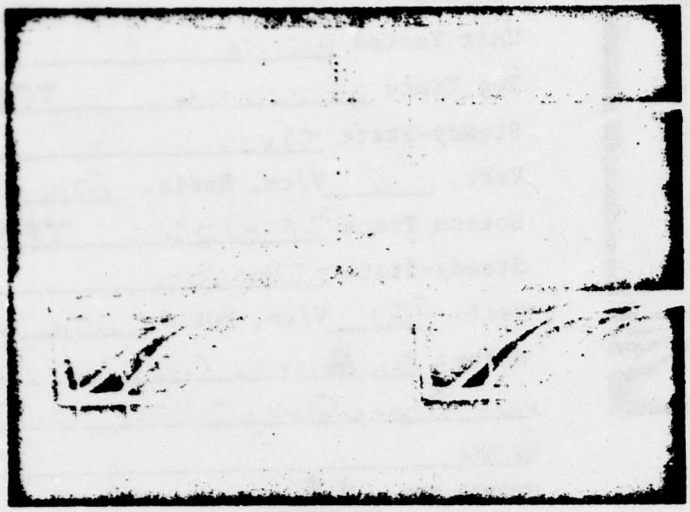
Horizontal 20m s/cm

Notes: ____

HELIX CURRENT TLM

Tech [illegible] Date 24Feb75

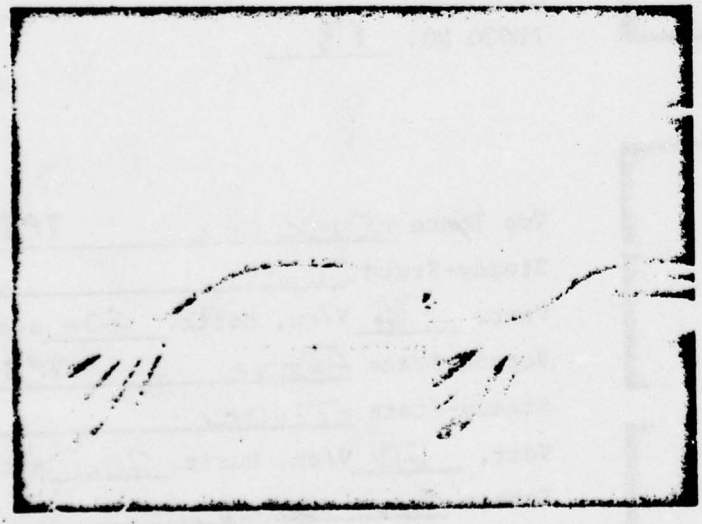
PHOTO NO. 9 RTE [illegible]



Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace 5VDC LINE
Steady-State +5 VDC
Vertical 5 V/cm
Bottom Trace J1-3 HELIX V TLM
Steady-State _____
Vertical 2 V/cm
Horizontal 20m s/cm
Notes: ALL SERIES RESISTANCE
IN 5VDC LINE ① 200K ② 150K
③ 120K ④ 100K ⑤ 70K

Tech _____ Date 4 MAR 75
RTE YDC

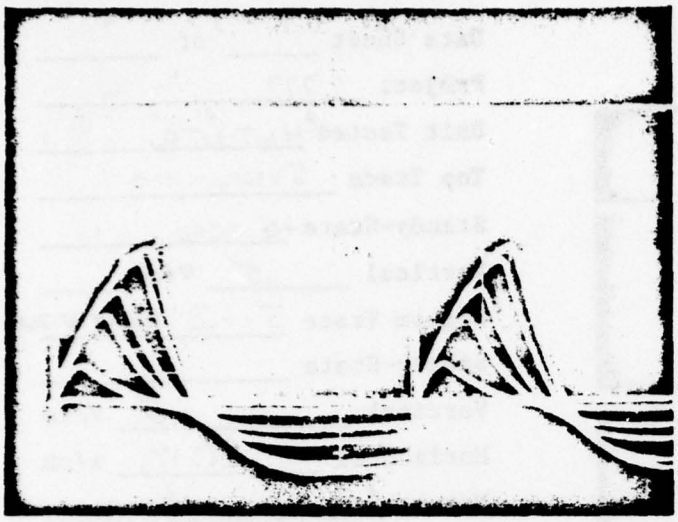
PHOTO NO. 10



Data Sheet _____ of _____
Project 777
Unit Tested HLTWTA
Top Trace 5VDC LINE
Steady-State +5.0 VDC
Vertical 5 V/cm
Bottom Trace +19 VDC LINE
Steady-State +19.4 VDC
Vertical 10 V/cm
Horizontal 20m s/cm
Notes: ALL SERIES RESISTANCE
IN 5VDC LINE ① OPEN ② 200K
③ 150K ④ 120K ⑤ 100K ⑥ 70K

Tech _____ Date 4 MAR 75
RTE YDC

PHOTO NO. 11



Data Sheet _____ of _____

Project 777

Unit Tested HET 5TA

Top Trace 5VDC LINE TP8

Steady-State +5VDC

Vert. 5 V/cm, Horiz. 20m s/cm

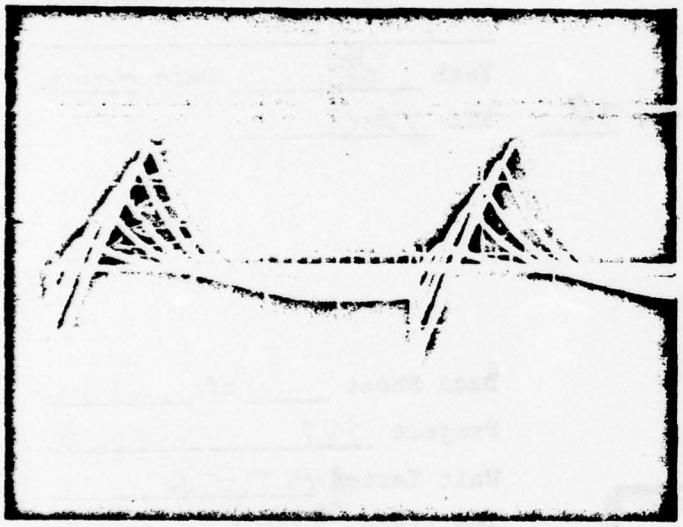
Bottom Trace CATHODE TP5

Steady-State -300VDC

Vert. 200 V/cm, Horiz. 20m s/cm

Notes: ALL Resistors Continuous +/- 5VDC LINE ① Open ② 200K ③ 150K ④ 120K ⑤ 100K ⑥ 90K

PHOTO NO. 12



Top Trace +5VDC LINE TP8

Steady-State +5.0VDC

Vert. 5 V/cm, Horiz. 20m s/cm

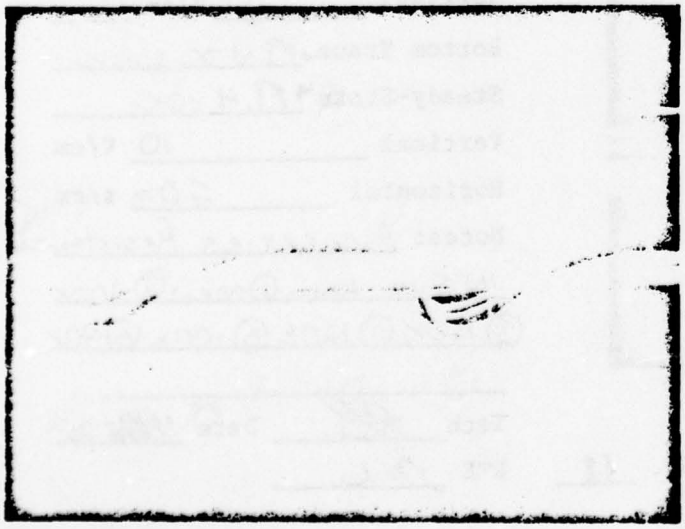
Bottom Trace COLLECTOR TP6

Steady-State -200VDC

Vert. 200 V/cm, Horiz. 20m s/cm

Notes: See NOTES ABOVE

PHOTO NO. 13



Top Trace +5VDC LINE TP8

Steady-State +5.0 VDC

Vert. 5 V/cm, Horiz. 20m s/cm

Bottom Trace ANODE TP7

Steady-State +77VDC

Vert. 20 V/cm, Horiz. 20m s/cm

Notes: See NOTES ABOVE

PHOTO NO. 14

Tech _____ Date 4 MAR 75

RTE _____

AUDIO SUSCEPTIBILITY TESTS

ENGINEERING NOTES ON THIS SECTION

1. Normal EMC/EMI test techniques and setups were used for high level audio susceptibility testing.

2. No significant responses were observed on the HV outputs at audio injection levels up to 10 times the levels imposed by the specifications but significant audio ripple was observed on the +19 VDC BUS.

3. The +19 V BUS shows a tolerance of $\pm$0.5 V on the schematics, therefore, an audio ripple level of 1.0 Volts, p-p, was chosen as a susceptibility criteria.

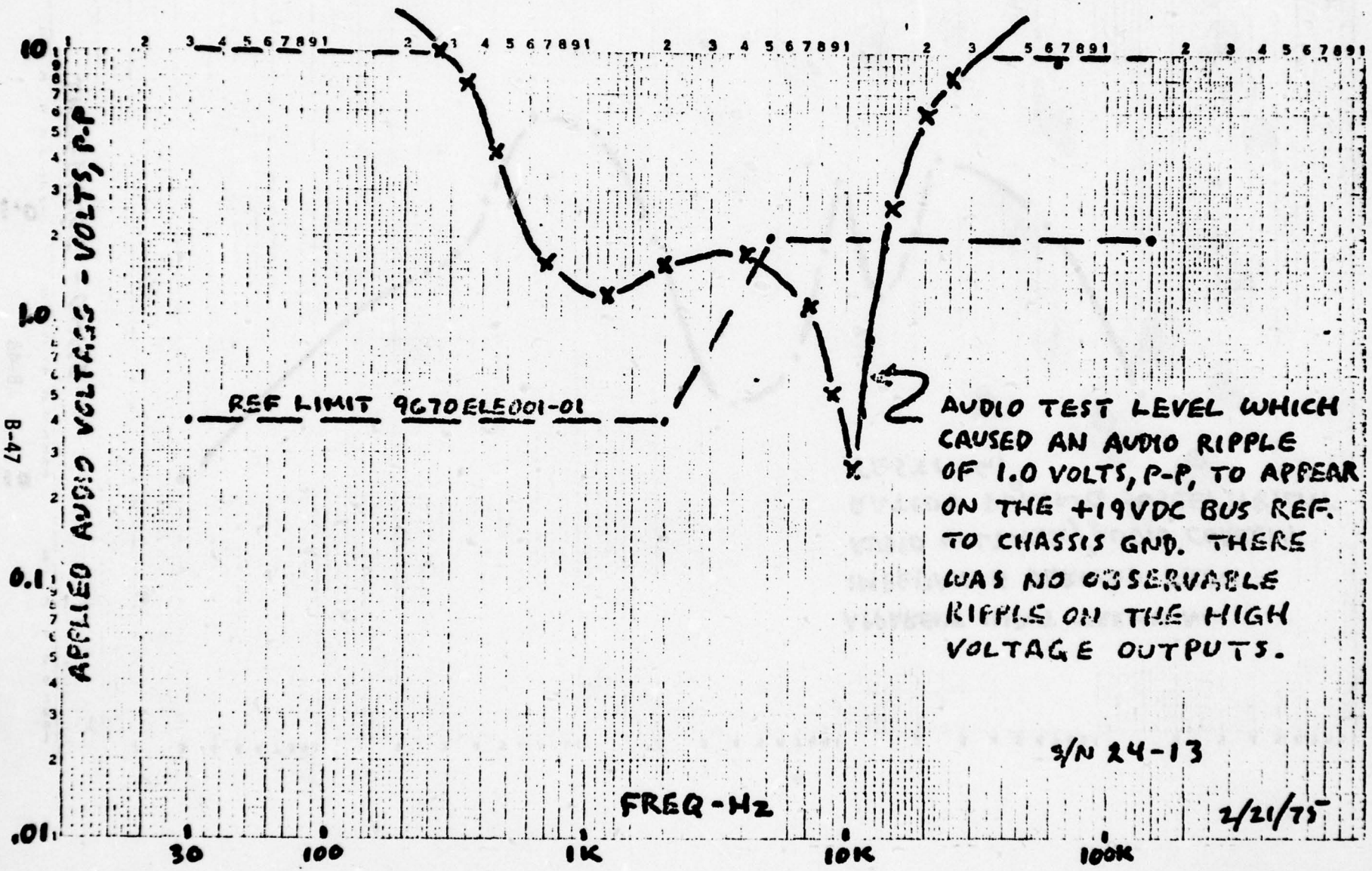
4. The audio voltage applied to the input power terminals which resulted in 1.0 volts, p-p, ripple on the +19 V BUS was then measured and recorded. These levels are shown on Figure 1.

5. The input audio current was also monitored. The ratio between input audio voltage and current is a measure of the apparent input impedance. This is shown on Figure 2.

6. A post-test critique (2 weeks later) indicates that the level of audio ripple on the +19 VDC BUS was probably a function of the L-C circuit on the negative side of the input filter. The ripple level referenced to the SIG RTN BUS was probably considerably less than the 1.0 volts, p-p, which is probably why there was no significant ripple on the HV outputs.

NO. 340-L35 DIETZGEN GRAPH PAPER
LOGARITHMIC
3 CYCLES X 5 CYCLES

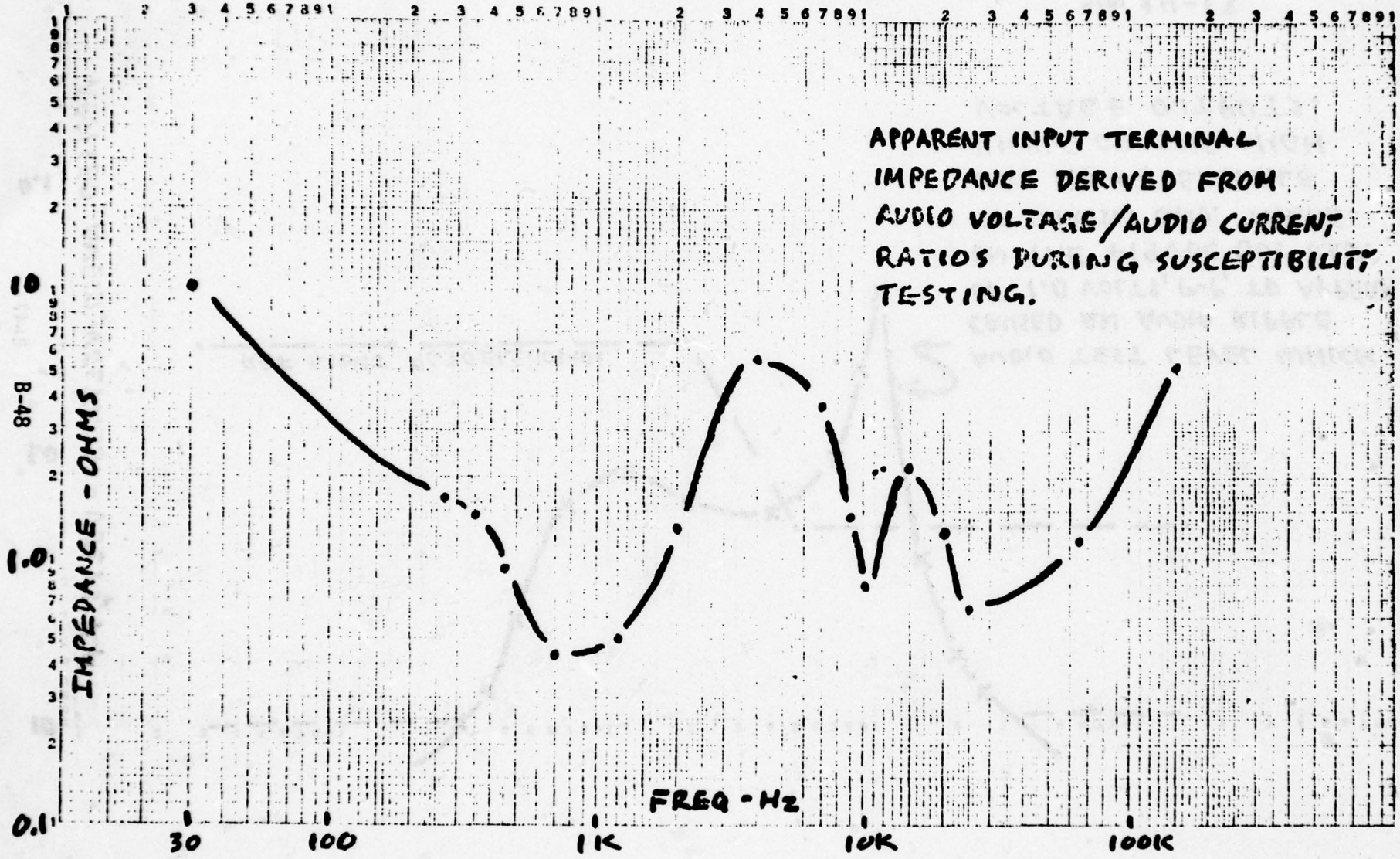
EUGENE DIETZGEN CO.
MADE IN U. S. A.



B-47

NO. 340-L35 DIETZGEN GRAPH PAPER
LOGARITHMIC
3 CYCLES X 5 CYCLES

EUGENE DIETZGEN CO.
MADE IN U. S. A.



MISCELLANEOUS TESTS

MISCELLANEOUS TESTS

1. RF Susceptibility: The unit was tested for RF susceptibility on its input power lines at 2 volts, p-p, (4 times specification) from 150 kHz to 400 MHz. No malfunctions noted.

2. Spike Susceptibility, Control Line: Positive spikes of 10 volt peak amplitude and 10 microsecond duration were superimposed on the +5 volt CMD Line. The resultant spike was 15 volts above chassis ground. No malfunctions noted. Negative spikes not performed because of danger to input capacitor.

3. Spike Susceptibility, Power Line: Not performed. Hughes qual test data on HLTWTA (by Genisco) stated successful compliance with spike test requirements. Examination of schematic indicates that the filter capacitors could be damaged by high level spikes, particularly negative spikes. Analysis indicates that spikes should not propogate through input filter inductors.

APPENDIX B-3

IOC 8231.2-163; EFFECTS ON HLTWTA POWER TIME
RIPPLE BY VARIATIONS IN RF LOADING; 27 DEC 1974, G.E. WILLEFORD

TRW
SYSTEMS GROUP

JAS

INTEROFFICE CORRESPONDENCE

8231.2-163

TO: A. Krausz CC: Distribution DATE: 27 December 1974

SUBJECT: Effects on HLTWTA Power Line Ripple by Variations in RF Loading

FROM: G. E. Willeford
BLDG. M2 MAIL STA. 1161 EXT. 63661

Reference: IOC 8231.2-162, "Review of HLTWTA Ground Test History versus On-Station Loading", from G. E. Willeford to A. Krausz, dated 6 December 1974.

An Engineering evaluation test program was performed on 26 December 1974 by 777 I&T and EMC Department personnel on the EC HLTWTA to determine the effects, if any, of variations in RF traffic loading upon the inherent ripple and noise characteristics of the input power and control lines.

Using various complex combinations of two fixed tuned carriers, and one swept frequency carrier, no detectable change in input current or voltage on either the power lines or the control line could be observed. These results indicate that the hypothesis advanced by the writer in the referenced IOC, and in verbal conversations with J. A. Durschinger, et al, does not appear to have merit. Further expenditures of engineering and technical support manhours on special test procedures along this track is therefore not warranted. It might, however, be advantageous to monitor the primary power lines and some selected secondary power lines on Flights 5 or 6 during a normal Comm Subsystem Test, in order to verify the results of the engineering tests with the HLTWTA integrated into an operational system.

G. E. Willeford

GEW:le

Distribution

B. Cooperstein
J. A. Durschinger
G. J. Gleghorn
D. J. Hiner
C. Sollo
J. A. Spagon

STEMS 0180 REV 7-67

APPENDIX B-4

IOC 8231.2-162; REVIEW OF HLTWTA GROUND TEST
HISTORY VS ON-STATION LOADING: 6 DEC 1974, G.E. WILLEFORD

TRW SYSTEMS GROUP

DEC 9 1974

INTEROFFICE CORRESPONDENCE

8231.2-162

TO: A. Krausz CC: Distribution DATE: 6 December 1974

SUBJECT: Review of HLTWTA Ground Test History vs On-Station Loading

FROM: G. E. Willeford

BLDG. M2 MAIL STA. 1161 EXT. 63661

Reference: IOC 8230-41, "777 Tasks (EMI Study)", A. Krausz to Distribution, dated 12 November 1974

Pursuant to Task #1 of the referenced IOC, a review of available historical documentation and interviews with key TRW personnel discloses that the 777 High Level TWT Amplifier design has been subjected to an extensive ground test program at unit, subsystem and satellite levels. This test program has adequately verified that the normal operational characteristics of the TWTA's do comply with all critical design requirements. However, there is no historical evidence available to the writer that indicates testing with RF traffic loading similar to that experienced on-orbit (i.e., high carrier density with complex modulation characteristics). The TWTA tests have normally been performed using single, unmodulated carriers to check frequency response, output power, gain, etc. Only during a few selected test sequences is a second carrier used, also unmodulated. The maximum number of carriers ever used at any level of testing at TRW appears to have been four (4) during an early test program on the engineering model.

The lack of multiple carrier testing would normally be justifiable since: (1) present testing methods do already confirm peak RF power loading capabilities; (2) testing with multiple carriers (10 to 30) would be difficult and costly to implement; and (3) with an unloaded TWT adjusted for maximum gain, the resultant output noise spectra can be construed to be worst-case carrier density. However, in light of the recent orbital anomalies which may have some relation to operational RF traffic loading, the existing test philosophy may need to be re-evaluated.

STEMS 0180 REV 3-67

A test program is now underway to determine the effects, if any, of plasma charging on the EC antenna and EC HLTWTA. During the course of this test, the power and control lines to the TWTA will be monitored with an oscilloscope for any deviations in ripple or noise voltages which can be correlated to variations in carrier spacing or modulation. A minimum of three (3) carriers will be used. In the event that these observations do disclose that there is a relationship between carrier density, spacing, or modulation and variations in ripple or noise on the power or control lines, then a more extensive test should be planned using the qualification model satellite as a test bed, to determine if there is any possibility of RF loading exciting abnormally high ripple or noise in the HLTWTA-PCU-SLA-HLTWTA loop via the 28 VDC primary power system and the +5 VDC control line.

G.E. Willeford

GEW:le

Distribution

B. Cooperstein
J. A. Durschinger
J. A. Spagon
C. Sollo

APPENDIX B-5

REPORT ON SPECIAL TEST TO INVESTIGATE
POSSIBLE TWTA FAILURE MODES RESULTING
FROM LOW INPUT COMMAND VOLTAGE, 31 JAN 1977, R.E. ALLEN

HUGHES
HUGHES AIRCRAFT COMPANY
ELECTRON DYNAMICS DIVISION

7 February 1977

In Reply Refer To:
EDD W-06372

TRW Inc.
1 Space Park
Redondo Beach, CA 90278

Attention: T. G. Reiten, M3/2153

Subject: HL TWTA Special Tests

References: (1) Subcontract A19148RPBS
(2) HEDD TWX, dated 12/20/76

Gentlemen:

Enclosed herewith are five copies of the "Report on special test to investigate possible TWTA failure modes resulting from low input command voltage", dated January 31, 1977.

Please call if you should desire any additional discussion concerning this report.

Very truly yours,

ELECTRON DYNAMICS DIVISION

A. M. Orta
Sr. Contracts Administrator

/hjm

Enclosures

3100 West Lomita Boulevard, Torrance, California 90509, Tel (213)534-2121, TWX 910-347-6238

Report on special test to investigate possible TWTA failure modes resulting from low input command voltage.

31 January 1977

Program: 1202HA

Subcontract No.: A19148RPBS

Prepared by: R. E. Allen
Program Manager: R. Harrington

INTRODUCTION

At the request of TRW, a series of tests were conducted at HAC EDD utilizing the 1202HA TWTA Breadboard. The HAC and TRW personnel who participated in part or all of the testing are listed here.

TRW	HAC
D. Cronin	R. E. Allen
C. Halbirt	R. Harrington
	V. W. Lym
	H. W. Smith (TWT Dept.)
	J. E. Travers

The tests were accomplished on 20, 21, 22 December 1976. The first day was used to set up the EPC (electronic power conditioner) breadboard, TWT 265HC S/N 511 and test equipment. The tests themselves were run on 21, 22 December. TRW personnel attended the tests on 21 December only.

PURPOSE OF TESTS

The purpose of the tests is to investigate the phenomena associated with the failure mode typified by the TWTA turning itself off at the end of the time-out interval. Such a failure has been observed in space. Three specific areas of interest were investigated in the tests.

1. TWTA modes of operation as functions of command voltage, E_{COM}, and input voltage, E_{IN}.

2. Power dissipation in the switching transistor, Q8, and its base resistor, A3R21, when the TWTA is in an unstable, steady-state mode of operation caused by low E_{COM}.

3. Transients that may appear in the input current (I_{IN}) and helix current (I_W) overcurrent trip circuit at the time high voltage comes on, which would actuate the circuit and turn the TWTA off. The physical point at which I_{IN} and I_W are summed and sampled for possible trip off is the capacitor A3C2, and the characteristics during high voltage turn on at this point are of interest.

DESCRIPTION OF TESTS

1. TWTA Modes as Functions of E_{COM} and E_{IN}.

This test was run using the EPC breadboard and TWT 265HC serial number 511, which were connected to form a TWTA of the 1202HA type. The effect of low values of E_{COM} on TWTA operation was investigated with the aim of finding out if the EPC and/or the TWT are damaged by operating in this way. The test was instrumented to record E_{BUS}, E_K, $E_{F\ TLM}$, $E_{K\ TLM}$, $I_{K\ TLM}$ and $I_{W\ TLM}$ continuously.

E_{BUS}: EPC Internal 19V Regulated Bus

E_K: EPC Output Cathode Voltage

$E_{F\ TLM}$: Heater Voltage Telemetry Output

$E_{K\ TLM}$: Cathode Voltage Telemetry Output

$I_{K\ TLM}$: Cathode Current Telemetry Output

$I_{W\ TLM}$: Helix Current Telemetry Output

A six channel Brush recorder was used to monitor these parameters. The format of the test was to turn on the TWTA with a command voltage of 5 volts and reduce the value to a level where the TWTA operates in a nonnormal mode. Two such modes were discovered:

1. The TWTA assumes a steady-state condition in which the monitored parameters are different from normal.

2. The TWTA appears to operate in the steady-state mode described in 1. above except that eventually E_F returns to a nearly normal value resulting in an increase in I_W to the point where the EPC turns itself off (referred to as I_W trip).

A comparison of the normal parameters with nonnormal Mode 1 and Mode 2 parameters is given in Table I.

TABLE I

RECORDED PARAMETERS

TWTA Mode	RECORDED PARAMETERS (Volts)					
	E_{BUS}	E_K	E_F TLM	E_K TLM	I_K TLM	I_W TLM
Normal	19.2	-3780	3.9	2.7	3.7	0.30
Mode 1 E_{COM} = 2.3V Steady-state	11 to 15	-2000 to -3300	0.1	0	1.3	3.1
Mode 2 E_{COM} = 2.3V I_W trip	11 to 15	-2000 to -3300	*	0	1.3	*

*E_F and I_W start the same as in the Mode 1 steady-state case but later E_F rises to a value slightly less than normal (3.9) and I_W rises several seconds later to the point that I_W trip occurs.

Tests conducted at the beginning of the testing period resulted in the EPC entering the steady-state mode 1 for $E_{IN} < 26$ volts and entering the I_W trip mode 2 for $E_{IN} > 26$ volts. After several minutes of testing the I_W trip mode 2 was not achieved at all in the range $23 < E_{IN} < 33$ volts.

The threshold value of E_{COM} is approximately 2.3 volts. Tests run with and without RF signal applied to the TWT had the same results. The TWTA characteristics observed in the tests are illustrated in Figure 1.

2. Power Dissipation in Q8 and A3R21

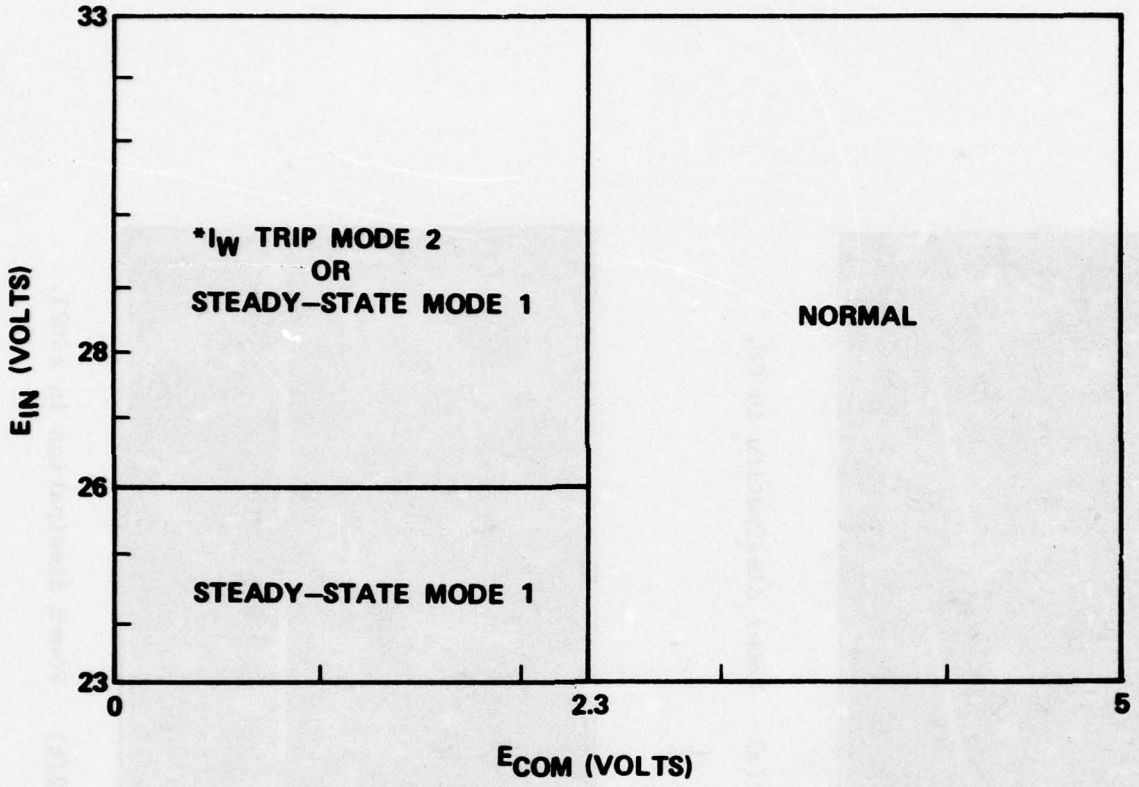
Although no failures occurred in either EPC or TWT during the tests described above, power consumption in the switching transistor, Q8, and its base resistor A3R21 increased. The power dissipated in these two components was measured while the TWTA was in the steady-state mode 1. The power in Q8 was calculated from the photograph in Figure 2(a) and the power in A3R21 was measured using a DC voltmeter with the benefit of the photograph in Figure 2(b). The values are:

$$P_{Q8} = 8 \text{ watts}$$

$$P_{A3R21} = 8.6 \text{ watts}$$

The derated power ratings for space applications for the transistor and resistor are, respectively, 50 watts and 1.5 watts. Because of the excessive overstress in A3R21 a test was run to investigate the effects on the resistor of operation at 8.6 watts in a vacuum. The test is summarized here.

Description of resistor: RWR89S15R0FR Resistor
(3W, 15Ω, 1%, wire wound)



*I_W TRIP OCCURS ONLY DURING THE FIRST FEW MINUTES OF OPERATION. AFTER "WARM UP," THE STEADY–STATE MODE 1 OPERATION IS ACHIEVED FOR THE ENTIRE RANGE OF E_{IN}.

Figure 1 TWTA modes of operation.

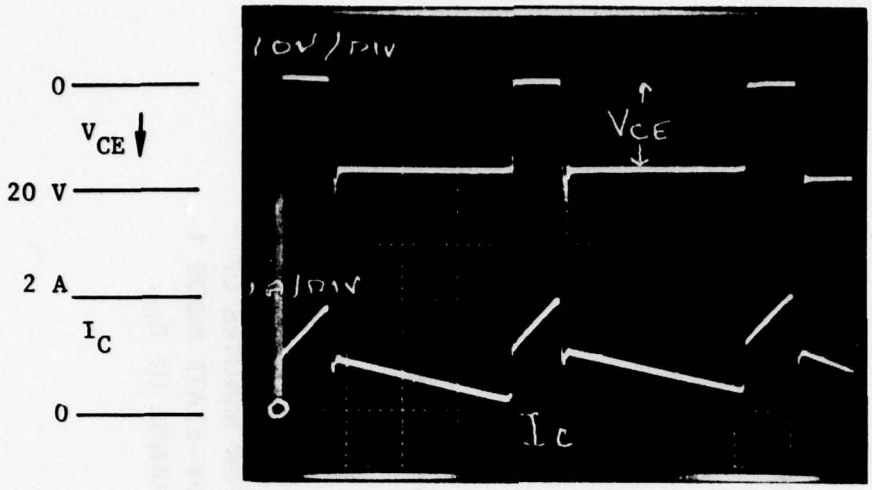


Figure 2(a) Power dissipation in Q8.

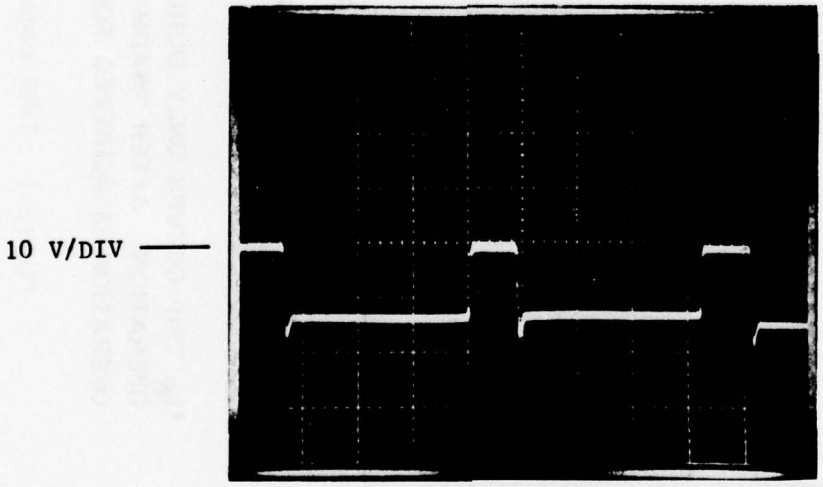


Figure 2(b) Power dissipation in A3R21.

Purpose: To investigate effects of operation at over rated power level in vacuum.

Test Conditions: Measured initial resistance: 14.90Ω
Applied Voltage: 11.4V dc
Applied Power: 8.7 watts
Current (power supply meter): 0.75 amps
Vacuum: 4×10^{-5} torr

Description: The resistor was mounted on a 1/16" epoxy glass, copper clad board to simulate actual equipment mounting. After the resistor was soldered to the board a piece of 63/37 solder was wrapped around one lead 5/32" from the end of the body to see if the temperature rise would be high enough to melt solder.

Results: Approximately two minutes after application of power the solder melted. Current remained stable indicating stable resistance.

A check was made at 1 hour. The current was still stable.

The next check was made at sixteen hours. The current had increased to 1.4 amps. The voltage was down to 10.8 Volts. The power supply was current limiting. The resistor was glowing. The epoxy board was charred.

Resistance measured 10.51 ohms after the resistor was removed from the chamber and allowed to cool for one hour.

The effects of failure of A3R21 on the TWTA was investigated by turning the breadboard on repeatedly each time with a different value of resistance in the ~~phase~~ place of A3R21 covering the range from zero to infinity and observing TWTA operation. The results are shown in Table II.

TABLE II

TWTA OPERATION WITH FAILED A3R21

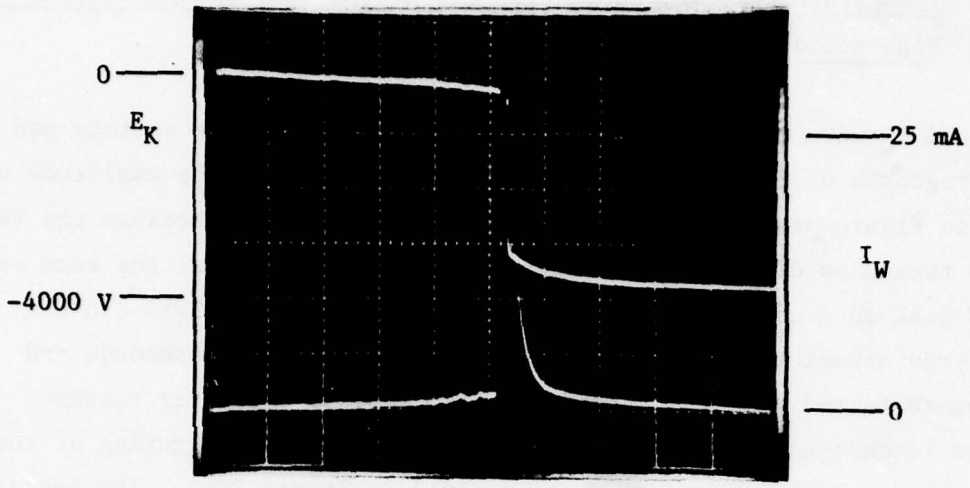
*A3R21 (ohms)	Description					
	During Time-Out			After Time-Out		
	Comments	E_{BUS} (Volts)	E_K (Volts)	Comments	E_{BUS} (Volts)	E_K (Volts)
0-45	Normal operation	20.34	--	Normal operation	19.30	-3794
45-100	Normal operation	20.34	--	Low E_{BUS} and E_K	≈9	≈-1800
100-1000	E bus comes up slowly (≈4 sec)	20.34	--	High voltage doesn't come on. Returns to time-out mode.	--	--
1000-600K	E bus comes up slowly (≈4 sec) high voltage inhibit doesn't work.	4 to 5	-100 to -1200	Tester stops time-out to protect TWT	--	--
600K-∞	Won't turn on	--	--	**Normal	19.30	-3794

*Ranges of A3R21 are approximate.
**A3R21 was disconnected after time-out.

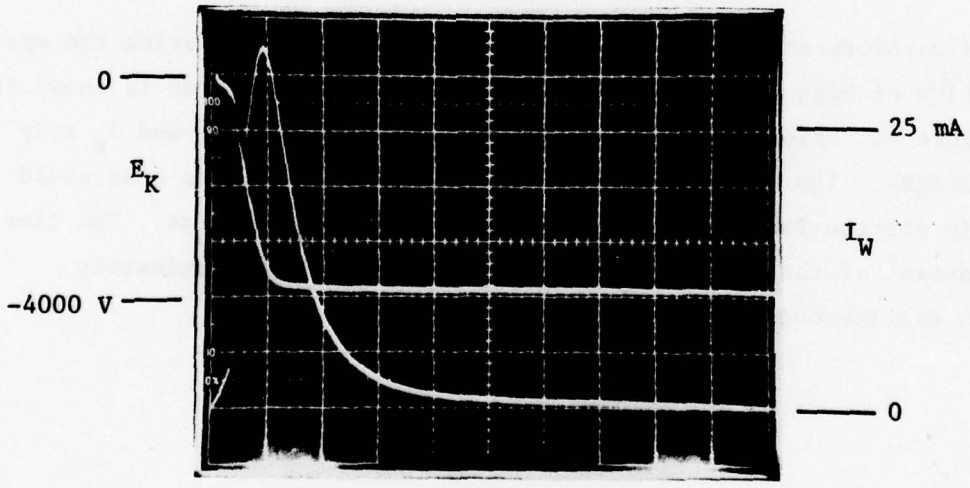
3. Transients that May Cause Trip Off at the Time of Application of High Voltage

E_K and I_W were monitored during the application of high voltage and photographs of the waveforms are shown in Figure 3. The amplitude of I_W in Figure 3(b) is larger than it is in Figure 3(a) because the TWTA was turned on differently in each case. For Figure 3(a) the turn on was done in a normal fashion, but for Figure 3(b) the TWTA did not undergo normal time-out but was turned off for about 5 seconds and then restarted and high voltage applied immediately after restart. This technique was used because it facilitated the triggering of the oscilloscope for the sweep speed desired in Figure 3(b). The increase in amplitude of I_W probably results from cooling of the cathode which occurs during the brief shut off period. During the application of high voltage I_W has a maximum value of 28 mA and the final values of E_K and I_W are achieved in about 20 milliseconds.

The waveform across A3C2 was monitored along with E_K during the application of high voltage and a photograph of the waveforms is shown in Figure 4. This capacitor is the summing point for I_{IN} and I_W trip voltages. The waveform is smooth and has no transients that could trip off the TWTA during the application of high voltage. The time constant of the circuit which charges up A3C2 is approximately 200 milliseconds.

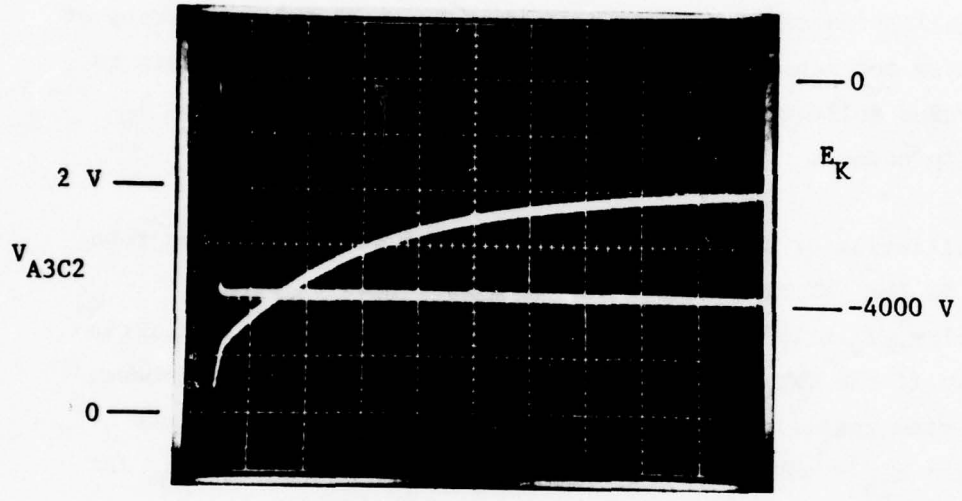


(a) 20 msec/div



(b) 5 msec/div

Figure 3 E_K and I_W during application of high voltage.



100 msec/div

Figure 4 I_{IN} and I_W trip summing voltage.

SUMMARY

The behavior of the TWTA with low command voltage is typified by nonnormal operation during which E_{BUS} drops by 4 to 7 volts, E_K drops by 400 to 1800 volts, E_F drops to a range of 0 to 70% of full voltage, and I_W increases to 3 or 4 mA. All of these parameters change slightly with time or may show an oscillatory type of behavior but basically a state of equilibrium exists. Sometimes when $E_{IN} > 26$ volts, a state of equilibrium is not achieved but after several seconds E_F increases to near full value followed several seconds later by an increase in I_W until I_W trip occurs.

Whether equilibrium or I_W trip occurs may be a function of prior tube activity. If the TWT is cold and the TWTA is turned on with $E_{IN} > 26$ volts, I_W trip will occur, and if $E_{IN} < 26$ volts, equilibrium will occur. If the TWT is warm, having been run for several minutes, the equilibrium condition may be achieved for all allowable values of E_{IN} ($23V < E_{IN} < 33V$). The apparent threshold voltage of E_{COM} for which these anomalies occur is approximately 2.3 volts. Operation of the TWTA in the nonnormal steady-state mode 1 results in increased power dissipation in the switching transistor, Q8, and its base resistor, A3R21. The ratios of normal-to-space derated power and nonnormal-to-space derated power for these components are:

	Normal	Nonnormal
Q8	1.5 watts / 50 watts	8 watts / 50 watts
A3R21	0.006 watts / 1.5 watts	8.6 watts / 1.5 watts

In a simulated space operation test the overstress of A3R21 caused the solder to melt after 2 minutes of operation. After 1 hour of operation the resistance had not changed from its nominal value of 15 ohms but after 16 hours of operation the resistance measured 10.51 ohms and the resistor was glowing. Breadboard tests showed that the TWTA operates normally when A3R21 lies in the range 0 to 45 ohms. When the resistance exceeds 45 ohms, EPC malfunction occurs as evidenced by low or zero values of E_{BUS} and E_K.

CONCLUSION

1. Neither the EPC nor the TWT is damaged by operation of the TWTA with low command voltage. Prolonged periods of operation in the non-normal steady-state mode 1 did not change the oeprating characteristics of the TWTA when it is turned on in a normal manner. For example I_W assumes normal values immediately upon turn-on after several hours of testing wherein nonnormal modes are sustained for extended periods.

2. Although operation of the TWTA in the nonnormal, steady-state mode 1 associated with low command voltage does not immediately damage the unit, the switching transistor, Q8, and its base resistor, A3R21, experience significantly increased power dissipation. Prolonged operation at the increased level could cause a failure of A3R21.

Prolonged operation at the increased level causes the resistor to glow, the solder to melt and the value of resistance to change. The circuit board in the vicinity of the overstressed resistor also chars. It is not likely that the circuitry would continue to operate properly after prolonged operation in this mode. Short periods of operation (not exceeding two minutes to prohibit possible melting of solder) in this manner are probably tolerable.

APPENDIX C

DATA PACKAGE COMMENTS AND FAILURE/DESTROY SUMMARIES

APPENDIX C-1

IOC DSCS-DS-1084, TWTA MANUFACTURING DATA REVIEW, 5 JULY 1977, P. H. FOWLER

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA 90278

INTEROFFICE CORRESPONDENCE

TO: W. Brannion

CC: See Distribution

RECEIVED
JUL - 8 1977
OFFICE OF
W. BRANNIAN

DATE: 5 July 1977
DSCS-D2-1084

SUBJECT: TWTA Manufacturing Data Review

FROM: P. H. Fowler
BLDG. R5 MAIL STA. 1220 EXT. 62787

Following are consolidated comments on manufacturing packages of current flight candidate amplifiers reviewed by self, J. Yurk, and D. Cronin.

Following are the packages reviewed:

14-15	24-19
14-19	24-20
14-20	24-21
14-21	24-22
14-22	24-23
14-23	24-24
14-24	24-25
14-25	24-26
14-26	(24-27 is not available for review as of 30 June 1977)

Following are comments suggesting Hughes or TRW action required to establish flight worthiness of these amplifiers:

General

There are a number of questions arising from repetitive problems and from peculiarities noted which, while not directly relatable to the actual failures, should be answered.

(a) High Voltage Drift. There are several occurrences of high voltage drift when SCM and HVM are mated. The problem is cured by changing the Q5 and Q6 pair which drive the high voltage transformers. However, it is not clear that end-of-life and worst-case conditions could not cause orbital problems.

(b) Cathode Activity Change at TWTA Level. Almost all tubes show an apparent marked increase in cathode activity when mated to the EPC. In many cases, the manufacturing data indicates that the filament voltage is above 5·6V, which would partly account for the effect. However, amplifiers 14-24 and 14-25 seem to show an increase in CAT without high Ef. Two concerns thus arise: Should

the Ef be set high when this is already said to be an exceptionally hot cathode; does the change in CAT indicate an undesirable rise in temperature for some other reason?

(c) Small signal gain variations and anomalies are frequent. Sometimes the amplifier is reworked (window cleaning, etc.), sometimes a waiver is requested. This parameter seems to act as a sensitive indicator for problems in the R.F. circuitry. It appears to the review team that closer attention and more consistency in diagnosing s.s.g. problems might be warranted. We request Hughes comment.

Particular: (No comment if not listed)

14-19: S.C. Module Test Failure: Q10 emitter resistor (1Ω1W) was found to be burned, was replaced. Module failed again, Q10 was found to be shorted. Problem was found to be A1T1 lead 4 was to 21, should be 28. Concerns are:

- Overstress analysis does not seem to have been performed. What about T1?
- On the face of it, the miswire does not seem to explain the problem.

H.V. Module: Was operated mated to SCM with R4 in feedback string open. Concern: Does this cause H.V. overstress?

14-20: Has been reworked twice for gain variation. Probably fixed by standard connector rework, but shall be monitored for further symptoms.

S.C. Module: Apparently built with pinched wire at the filament transformer drive Q3 collector. Concern: Transformer overstress (however, current is limited to 350 ma--not serious concern).

14-21: Note to TRW--monitor CAT is stable.

14-22: (One of the amplifiers which had the Q5-Q6 problem.)
Helix current has abnormal behavior during activity test (e.g., see 750 HR point in tube burn-in). Concern: Possibility this tube is in some way (e.g., focus) marginal.

14-23: Reviewers could not reconcile final telemetry voltages with expected amplifier behavior--do not know any problem, but request Hughes check. R7 was changed in the S.C. Module after start of TWTA burn-in. It appears this should have a failure report and analysis of why it was reworked at

this level of assembly. (Failure report is required for any unscheduled adjustment after first power on the unit). Appears to need a Hughes failure report and FRB closeout.

14-24: S.C. Module. Q6 on B200363-110 board (JANTX2N2222A) was good at board test and E-C short at module test. Concern: Cause? Overstress?

14-26: This unit contains the S.C. module removed from 24-19 for the H.V. drift problem. The module had substantial testing including thermal cycling attempting to diagnose, eventually had Q5/Q6 changed.
The tube (482) and H.V. module (010) in this amplifier were originally in an amplifier K-004 which would not turn on as an amplifier even though all the modules work. Concerns: The S.C. module has been overworked, and the tube and HVM are suspect until K-004 is explained.

24-20: (Another that had Q5/Q6 changed for H.V. drift.)

24-22: C6 and AR1 replaced "failed in test". Concern: Cause? Overstress?

24-23: Tube level testing had "fluctuating output power in thermal vac", see ITR 05869. Concern: Was problem diagnosed?

24-24: S.C. Module: Module had power applied and burned out Q10 and A1 at or about 4-9-76, 6-24-76, 7-19-76. After last incident A1T1 lead 9 was found to be on 22, should be 21. 22 is Q10 base. Concern: T1 overstressed?

H.V. Module: Turned on at command (no timer) due to open at logic board te terminal 25 in SCM. Concern: Overstress? High voltage overshoot?

Distribution

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RECEIVED
JUL - 8 1977
OFFICE OF
W. BRANNIAN

INTEROFFICE CORRESPONDENCE

TO: W. Brannion

CC: see Distribution

DATE: 6 July 1977

SUBJECT: 24-27 TWTA Manufacturing Data Review

FROM: P. H. Fowler

BLDG. R5 MAIL STA. 1220 EXT. 62787

Subject package was reviewed to complete the data packages. I have the following comments:

1. S.C. Module 002 was tried in this unit and was replaced by 005. 002 is the prototype "H.V. drift" module which is now in 14-26. Presumably the replacement was for the H.V. drift problem, but this is not clear from the paper. Action: Hughes confirm.

2. S.C. Module 005 also failed, was found to have T1-6 and T1-7 reversed. There were copies of pages of the engineering log in the package, but it was not clear how they relate. Action: Hughes confirm no overstress.

3. The unit was built with tube 529, and had an amplifier level failure due to the Helix current going over the trip point at temperature (146°F). Per Walt Jordan, this was due to faulty focus and the procedure has been changed to raise the test temperatures at tube level. There was no failure report in the package, which Hughes states is because the tube which failed was replaced by 527. However, since the amplifier had the failure it seems clear that the TFR should be in the package. This is another example of an apparently basic mutual misunderstanding of the intent and purpose of the reliability program. Action: TRW ensure failure report is in the system. I suggest 777 Reliability review the Hughes Reliability plan and correct it and/or ensure adherence to it. Note that Hughes is under the impression that failure reporting is not required on RTV items, so the two amplifiers which failed in thermal vacuum screening did not get TFR's.

4. The fresh tube, 527, has a peculiarity. At each CAT there is noise on the helix current, varying in magnitude from test to test. It occurs at tube level test, but is especially noticeable at final amplifier test. Action: Hughes confirm this peculiarity is not indicative of any potential problem (e.g., loose magnet).

5. A previously reviewed package, 14-22, shows a helix trace which might indicate marginal focus. In light of (3) above, should this tube have a special high temperature test? Action: Hughes comment.

Distribution:

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V. Vidugiris
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J. Yurk

APPENDIX C-2

NOTES ON HISTORY OF S/N 24-17 HIGH VOLTAGE MODULE

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(1)

B200361-140 H.V. Module S/N 002 Sequence.

2/9/76 Rework O.S. -1 to replace all Bridges (Defective Lot)
2/17/76 Completed Rework O.S. -1.
3/8/76 Initial Functional test, with H.V. module Tester, performed OK.

3/9/76 started Integration test of H.V. Mod. 002 & S.C. Mod 002

3/10/76 continued Int. Test & found Drift of E_b.

3/11/76-3/18/76 Unit in Evaluation (T.V., B.B., etc.)

3/19/76 Rework O.S. -2 to Replace T-1 (collector X-former).

3/23/76 Rework O.S. -2: As repeat of Initial Functional Test was being performed; using H.V. module Tester, unit drew excessive current. (Voltage is started at zero and shall not exceed 2A at 10V. When unit exceeded 2A at less than 10V, it was shut off.)

Unit was set aside for Priority DX unit.

3/24/76 Unit was wire checked with no anomalies found.

Functional test performed normally and unit completed -2 Rework O.S.

3/25/76 Re-started Int. Test of H.V. 002 & S.C. Mod 002. Drift again found in E_b.

Substituted Collector filter caps external to unit & Drift stopped.

3/26/76 Rework O.S. -3 to replace C2 & C7.
3/29/76 Completed Rework O.S. -3.

4/2/76 NOTE: AT THIS POINT, MATED S.C. MODULE 002 & H.V. MODULE 005. DATA AVAILABLE IN OTHER PACKAGES, AND TESTING TOOK SEVERAL DAYS DUE TO PRIORITIES, BUT THE SAME DRIFT IN E_b WAS FOUND.

4/13/76 Started Ant. Test of H.V. module 002 & S.C. module 005.
"S.C. module appeared to fail when taking bus voltage reading."

units then separated.

H.V. module placed in Vacuum chamber for test, no anomalies.-

4/14/76 Re-Test H.V. module as OK in Vacuum Chamber.

Re-assigned S.C. module S/N 002 and re-started Ant. Test. at time out, Drew excessive current & tripped. Separated modules.

H.V. module S/N 002 tested separately & exceeded 2A at much lower than 10V.

4/15/76 NOTE: H.V. MODULE 005 WHICH HAD DRIFT WITH S.C. MODULE 002 WAS TESTED OK WITH S.C. MODULE 004.

4/20/76 Rework O.S. -4 started troubleshooting H.V. module & found shorted CR12.

CR12 replaced.

Unit re-tested on module tester as OK.

5/4 & 5/5 Ran Ant. Test. & Regulation Curves on H.V. module 002 & S.C. module 006.

5/10/76 Ran Integrated Functional Test.

5/13/76 Unit Potted.

5/17/76 Excess Potting machined off. (O.S. 361402-M)

(3)

Brackets

5/17/76 ITR 82761 issued for damaged nutplate threads in machining.

5/18/76 Rework O.S. -5 to repair nutplate.

5/20/76 Tested in module Tester OK.

5/20/76 Performed Corona Test OK.

5/21/76 Unit closed to Stores.

NOTE: (The Drift problem was subsequently traced to a "mismatch" in switching times of Q5 & Q6 in the S.C. modules. As a result, the Integration Sequence was changed to match the S.C. module to an assigned H.V. module prior to foaming.)

APPENDIX C-3

COMPILATION OF RELIABILITY ANALYSIS REPORTS FROM ORIGINAL 777 PROGRAM

RELIABILITY ANALYSIS REPORT NUMBER V65546 ACI91 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED 06-18-71
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED 08-26-71
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY BLANK
ORIGINATOR'S NAME	BRYANT	EM	TEST PROCEDURE	8200350-400	FAILURE CAUSE WORKMANSHIP
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY EHO SUPPLIER
RELIABILITY ENGINEER	BRYANT	EM	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000	

ASSEMBLY NAME	HTWT	PART NO.	200350	SERIAL NO	002	MANUFACTURER	
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING FIRST FUNCTIONAL TEST UNIT DREW HIGHER THAN NORMAL INPUT CURRENT DURING HEATER WARM-UP. SHOULD BE ABOUT 300MA, WAS ABOUT 500MA.

FAILURE ANALYSIS.

TROUBLESHOOTING REVEALED A PINCHED WIRE IN SEMICONDUCTOR MODULE. WIRE IS A TEST POINT LEAD FROM COLLECTOR OF Q2 (908806-1) TO TERMINAL E5. WHEN WIRE WAS REMOVED AND REPLACED UNIT RETURNED TO NORMAL OPERATION. REF. HUGHES REPORT NO 2350.

CORRECTIVE ACTION/COMMENTS.

ASSEMBLY AND INSPECTION PERSONNEL WERE INFORMED OF THE CAUSE OF FAILURE (WORKMANSHIP) AND CAUTIONED CONCERNING PROPER ROUTING OF WIRES. SUFFICIENT TESTING CURRENTLY EXISTS TO DETECT THIS FAILURE MECHANISM. ---FRB ACTION: CLOSED 20TH FRB, 8/26/71.

workmanship

RELIABILITY ANALYSIS REPORT NUMBER V65549 AC191 --- REPORT NO. 21 08-29-75

PROJECT	B-777		TEST LEVEL	3	DATE INITIATED	07-22-71
SYSTEM S N			TEST TYPE	ACCEPTANCE	DATE CLOSED	08-26-71
SUBSYSTEM NAME	COMM		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME			TEST PROCEDURE	B200350-400	FAILURE CAUSE	SPECIFICATION
MFG CCC	BRYANT	FM	PARAGRAPH NO.	10.0	RESPONSIBILITY	ENG SUPPLIER
RELIABILITY ENGINEER	TROCK	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	NONE IMPLEMENTED
RESPONSIBLE ENGINEER			CUM CYCLES	000		

ASSEMBLY NAME HTWT	PART NO. 200350-122	SERIAL NO 022	MANUFACTURER
SUBASSEMBLY NAME	PART NO.	SERIAL NO.	MANUFACTURER
DETAIL SUBASSY	PART NO.	SERIAL NO.	MANUFACTURER
COMPONENT PARTS	PART NO.	SERIAL NO.	MANUFACTURER

DESCRIPTION OF FAILURE.

PRIMARY POWER EXCEEDS SPECIFICATION AT 146 DEGREES F. BASEPLATE SHOULD BE 103 WATTS MAXIMUM, IS 110.8 WATTS WORST CASE.

FAILURE ANALYSIS.

THE OUT-OF-TOLERANCE CONDITION REFERENCED ABOVE IS A PERFORMANCE DEVIATION AND IS NOT CONSIDERED TO BE AN EQUIPMENT FAILURE. RESISTOR R7, A SELECT-IN-TEST RESISTOR WAS RESELECTED TO LOWER HELIX HUMP POWER CONSUMPTION AT 146 DEGREES (F). AFTER RESELECTION, WORST CASE POWER IS 103.6 WATTS. THIS VALUE IS ACCEPTABLE AND HUGHES HAS BEEN GIVEN A WAIVER FOR THE PRESENT OOT CONDITION.

CORRECTIVE ACTION/COMMENTS.

NONE REQUIRED. ALL OTHER UNITS ARE BUILT AND WITHIN TOLERANCE. --- FRB ACTION: CLOSED 20TH FRB, 8/26/71.

Test Team

RELIABILITY ANALYSIS REPORT NUMBER V58609 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	07-07-70
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	12-18-70
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	TEMPERATURE	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA AM	TEST PROCEDURE		FAILURE CAUSE	DEFECTIVE PART
MFG CCC	VEND	PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TROCK,P	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	810542	SERIAL NO.	002	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING FUNCTIONAL TESTING AT 50 DEGREES F PER HUGHES TEST PROCEDURE B200352-400, PARAGRAPH 5.3.3, THE UNIT WOULD NOT RESPOND TO THE ON COMMAND. (POWER SUPPLY P/N B200352-120, S/N NO. 002). REFERENCE HUGHES FR NO. 2306 AND TWX 910-347-6238.

FAILURE ANALYSIS.

FAILURE WAS FOUND TO BE A DEFECTIVE TRANSISTOR Q1 (2N222A) IN SEMICONDUCTOR MODULE, P/N B200362-110, S/N 004. THE CAUSE OF THE TRANSISTOR Q1 FAILURE WAS EXCESS CURRENT DURING TURN-ON THROUGH CAPACITOR C1. DURING TURN-ON OF Q1, TRANSISTORS Q1 (2N222A) AND Q2 (2N2907A) ACT AS A REGENERATIVE SWITCH AND THE RISE TIME OF ANY CURRENT PULSE THROUGH Q1 IS A FUNCTION OF ITS BANDWIDTH AND CALCULATED CURRENTS. AN EXCESS OF 1 AMP MAY FLOW IN THE COLLECTOR OF Q1 DURING SWITCHING IN THE ABSENCE OF A 100 OHM RESISTOR. THE 100 OHM RESISTOR ACTS AS A CURRENT LIMITING DEVICE.

CORRECTIVE ACTION/COMMENTS.

A 100 OHM RESISTOR HAS BEEN ADDED IN SERIES TO THE CIRCUIT TO LIMIT THE TURN-ON CURRENT PULSE TO A SAFE VALUE (REF. ECN 813308). EFFECTIVITY ALL UNITS. SAME FIX HAS BEEN ADDED TO LOW LEVEL POWER SUPPLIES AS A PRECAUTIONARY MEASURE (REF ECN 813313). CLOSED AT 18 DECEMBER 1970 RRB

design chg
not HV

RELIABILITY ANALYSIS REPORT NUMBER V58616 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	08-21-70
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	11-20-70
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	OSTA AM	TEST PROCEDURE	B200350-400	FAILURE CAUSE	DEFECTIVE PART
MFG CCC	VF10	PARAGRAPH NO.	10-4	RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	NONE IMPLEMENTED
RESPONSIBLE ENGINEER	WILLARD W	CUM CYCLES	000		

ASSEMBLY NAME	HPWT	PART NO. 310542	SERIAL NO 002	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER	
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER	
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING THERMAL VACUUM TESTING PER HUGHES EDD TEST PROCEDURE B200350-400, PARA. 10-4, AN APC OCCURRED AT 500 MICRONS PRESSURE. THE UNIT WOULD NOT RESTART AT AMBIENT CONDITIONS. REF. HUGHES EDD TWX NO. 910-347-6238, MALFUNCTION NOTIFICATION NO. 2310.

FAILURE ANALYSIS.

HIGH LEVEL POWER POWER SUPPLY IS UNABLE TO MEET TRW SPEC. REQUIREMENTS.

CORRECTIVE ACTION/COMMENTS.

HUGHES IS COMPLETELY RECESIGNING AND REBUILDING ALL HIGH LEVEL POWER SUPPLIES. NO FURTHER CORRECTIVE ON THIS TDR REQUIRED. CLOSED AT 20 NOVEMBER 1970 ERB

R V Mahaney

RELIABILITY ANALYSIS REPORT NUMBER V76706 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	09-08-70
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	11-20-70
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	DATA	TEST PROCEDURE	B200350-400	FAILURE CAUSE	WORKMANSHIP
MFG CCC	VEND	PARAGRAPH NO.	10.0 STEP 3	RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	HILLARD W	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	003	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING OF THE HIGH LEVEL TWTA, THERMAL/VAC ENVIRONMENT, THE UNIT ARCED FROM CASE TO POINT WHERE POWER SUPPLY AND TWT CONNECTIONS ARE MADE. REFERENCE HUGHES MALFUNCTION NOTIFICATION NO. 2312.

FAILURE ANALYSIS.

FAILURE WAS CAUSED BY HUMAN ERROR BECAUSE TEST HOLES IN POTTING COMPOUND AROUND PS-TWT CONNECTIONS WERE NOT "FILLED" PRIOR TO SUBJECTING UNIT TO THERMAL VACUUM TESTING.

CORRECTIVE ACTION/COMMENTS.

UNIT WAS REWORKED TO CORRECT PROBLEM AND RETESTED. PERSONNEL HAVE BEEN INSTRUCTED THAT PENETRATION OF HIGH VOLTAGE ENCAPSULANT IS AUTHORIZED ONLY UNDER ENGINEERING DIRECTION AND ONLY AFTER DETAIL WORK PROCEDURES HAVE BEEN NOTED ON THE REWORK OPERATOR INSTRUCTION SHEETS. CLOSED AT 20 NOVEMBER 1970 FRB

workmanship

RELIABILITY ANALYSIS REPORT NUMBER V76749 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	11-18-70
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA A	TEST PROCEDURE		FAILURE CAUSE	DESIGN
MFG CCC	VEND	PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HVMT	PART NO.	310542	SERIAL NO.	003	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING HIGH LEVEL HIGH VOLTAGE MODULE(S/N003) SPECIAL SCREEN TESTING, HIGH VACUUM ENVIRONMENT, UNIT OPERATED SUCCESSFULLY AT VACUUM WITH LOAD, FOR ONE HOUR AND FIVE MINUTES, AND 4200 VOLTS. POWER WAS TURNED-OFF AND LOADS REMOVED. POWER WAS TURNED ON AGAIN WITH LOADS REMOVED AND UNIT RAN FOR FIVE MINUTES AT 4200 VOLTS. SUDDENLY VOLTAGE DROPPED TO 3100 VOLTS. POWER WAS TURNED OFF AND LOAD CONNECTED. UPON TURN-ON WITH LOADS CONNECTED, UNIT DREW HIGH CURRENT (ABOUT 4 AMPS). UNIT WAS TURNED-OFF AND REMOVED FROM THE CHAMBER (REF. HUGHES MALFUNCTION NOTIFICATION #2318).

C-19

FAILURE ANALYSIS.

ANALYSIS OF THE HIGH VOLTAGE REVEALED TRANSFORMER T1 (8850000-040) TO BE SHORTED PRIMARY 1-2-3 TO WINDINGS 5-6 AND OPEN (47K) ON WINDINGS 4-5. ALSO THE ANODE BRIDGE Z1 WAS SHORTED PLUS TO MINUS. THE ANODE BRIDGE WAS SHORTED TWO DIODES IN ONE LEG (CR1 AND CR4). ALL EVIDENCE INDICATES THAT THE SEQUENCE OF EVENTS WERE: (1) Z1 VOLTAGE TRANSIT SUCH AS ARC OR CORONA OF MOST LIKELY CATHODE VOLTAGE TO PLUS TERMINAL ALSO SHORTING PIN 5 TO 1-2-3. (3) CURRENT SURGE ALSO SHORTING DIODES CR1 AND CR4. (4) SHORTED PRIMARY ALLOWS UNIT TO DRAW HIGH CURRENT.

CORRECTIVE ACTION/COMMENTS.

CIRCUIT DESIGN CHANGES TO BE INCORPORATED TO ELIMINATE TRANSIENT HIGH VOLTAGE SPIKES. ALSO, TEST PROCEDURE CHANGED TO ENSURE THAT THE HIGH VOLTAGE MODULE IS NEVER TESTED WHILE UNLOADED DURING VACUUM SCREEN TEST.

RELIABILITY ANALYSIS REPORT NUMBER V76516 AC121 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	
SYSTEM S N			TEST TYPE	ACCEPTANCE	
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	THERMAL VACUUM	
ORIGINATOR'S NAME	[illegible]A	AM	TEST PROCEDURE	ATP8200350	
MFG CCC			PARAGRAPH NO.		
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000	

DATE INITIATED	02-19-71	ASSEMBLY NAME	HTWT	PART NO. 310542	SERIAL NO 004	MANUFACTURER	HUGHES
DATE CLOSED	03-23-71	SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER	
CRITICALITY	BLANK	DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER	
FAILURE CAUSE	WORKMANSHIP	COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER	
RESPONSIBILITY	TRW SUPPLIER						
CORRECTIVE ACTION	NONE IMPLEMENTED						

DESCRIPTION OF FAILURE.

DURING HTWT ACCEPTANCE TESTING, THERMAL (146 DEGREES F)/VACUUM ENVIRONMENT CATHODE VOLTAGE TELEMETRY WAS NOT REPEATABLE (REF. HUGHES MALFUNCTION NOTIFICATION #2330).

FAILURE ANALYSIS.

PROBLEM WAS TRACED TO VP5 ZENER DIODE (JANTX 1N969B) IN THE CATHODE TELEMETRY CIRCUIT. DIODE WAS REMOVED FROM THE CIRCUIT AND TESTED TO SPECIFICATION AT BOTH ROOM AND ELEVATED TEMP. THE DIODE WAS WITHIN SPECIFICATION AND THE ANOMALY COULD NOT BE REPEATED AT THE PART LEVEL. THE MOST PROBABLE CAUSE WAS AN INTERMITTENT SOLDER CONNECTION TO THE DIODE. VP5 ZENER DIODE WAS REPLACED AND THE UNIT RTOK.

CORRECTIVE ACTION/COMMENTS.

SINCE THE EXACT FAILURE CAUSE COULD NOT BE IDENTIFIED AND THIS FAILURE WAS NEVER CONFIRMED, SPECIFIC CORRECTIVE ACTION CANNOT BE IDENTIFIED. FRB ACTION: CLOSED 3-23-71.

workmanship

RELIABILITY ANALYSIS REPORT NUMBER V76524 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	03-05-71
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	04-27-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	LEWIS	TEST PROCEDURE	EQ4-064	FAILURE CAUSE	OPERATOR
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTMT	PART NO.	310542	SERIAL NO.	004	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

HEATER TELEMETRY ZENER DIODE VR4 OPEN

FAILURE ANALYSIS.

DIODE WAS VERIFIED AS OPEN. DIODE HAD CLEARLY BEEN OVERLOADED AND OPENED AT TIP OF S RIBBON. IT WAS FOUND THAT A FULL 28 VOLTS WAS INADVERTANTLY APPLIED ACROSS THE TELEMETRY DIODE. DURING INRUSH CURRENT TEST SCOPE CASE FLOATS AT 28 VOLTS AND TELEMETRY POINT IS UTILIZED AS A SCOPE TRIGGER FOR INRUSH MEASUREMENT. DURING HOOKUP FOR TESTING THE TEST PROBE WAS TOUCHED TO THE CASE WHICH PUT 28 VOLTS ACROSS THE DIODE AND THEREBY OVERLOADED IT UNTIL IT OPENED.

CORRECTIVE ACTION/COMMENTS.

REMOVE AND REPLACE VR4 AND REWORK TO SPECIFICATION. TEST OPERATOR WAS CAUTIONED. MINIMUM 10K RESISTANCE PROBE WILL BE USED IN THE FUTURE SO THAT SHOULD PROBE INADVERTENTLY TOUCH THE SCOPE CASE, THE DIODE WILL BE PROTECTED FROM CURRENT OVERLOAD. --- FRB ACTION: CLOSED 4-27-71

test error

12-2

RELIABILITY ANALYSIS REPORT NUMBER V58615 AC121 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	07-29-70
SYSTEM S/N		TEST TYPE	BURN IN	DATE CLOSED	10-02-70
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	MURPHY MC	TEST PROCEDURE	B200352-400	FAILURE CAUSE	PROCESS
MFG CCC	VEND	PARAGRAPH NO.	5.2.1	RESPONSIBILITY	TWX SUPPLIER
RELIABILITY ENGINEER	WONG N	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DRAWING REVISION
RESPONSIBLE ENGINEER	AUBOL P	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	005	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING TWTA BURN-IN TEST PER HUGHES EDD SPECIFICATION B200352-400, PARA 5.2.1, ARCING WAS DETECTED IN THE AREA OF THE HIGH VOLTAGE MODULE, P/N B200361-110, S/N 006, IN THE HIGH LEVEL POWER SUPPLY, P/N B200352-120, S/N 005.

FAILURE ANALYSIS.

FAILURE ANALYSIS PER HUGHES EDD TWX 910-347-6238, DATED 7/29/70, AND MALFUNCTION REPORT NUMBER 2307, IS AS FOLLOWS: PRELIMINARY MEASUREMENT REVEALED A HIGH RESISTANCE SHORT BETWEEN CHASSIS AND HEATER-CATHODE LEAD. RESISTANCE COULD BE VARIED SLIGHTLY BY PRESSING ON HIGH VOLTAGE MODULE CHASSIS. AFTER X-RAY OF THE HIGH VOLTAGE CHASSIS THE AREA OF CONTINUITY WAS ISOLATED TO A POINT BETWEEN THE END OF CONDUCTIVELY WRAPPED DIODE BRIDGE ASSEMBLY AND CHASSIS. THE X-RAY INDICATED A PINCHED WIRE BETWEEN HIGH VOLTAGE MODULE CHASSIS AND CONDUCTIVELY WRAPPED BRIDGE ASSEMBLY.

CORRECTIVE ACTION/COMMENTS.

AS CORRECTIVE ACTION ENGINEERING CHANGE NOTICE 813375 HAS BEEN RELEASED TO SHOW THE WRAPPING OF DIODES CR3 AND CR4 AS A PAIR AND BONDED TO C7(SEE DRAWING B200374). THIS ASSEMBLY WILL ALLOW CONTROL OF THE POSITIONING OF THE DIODES IN A FASHION WHICH WILL NOT ALLOW THEM TO BE POSITIONED NEAR THE BRIDGE ASSEMBLY. S/N 006 HIGH VOLTAGE MODULE WAS REMOVED, & SCRAPPED. S/N 012 MODULE WAS REPLACED. CLOSED AT 2 OCTOBER 1970 FRB.

RELIABILITY ANALYSIS REPORT NUMBER V76531 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	04-06-71
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	05-25-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	DOTA AM	TEST PROCEDURE	EQ4-664	FAILURE CAUSE	TEST EQUIPMENT
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	006	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING OF THE HTWT, THERMAL/VACUUM ENVIRONMENT, RF POWER WAS UNSTABLE AT 146 DEGREES F. (REF HUGHES MALFUNCTION NOTIF. #2334)

FAILURE ANALYSIS.

THE PROBLEM OF UNSTABLE RF POWER OUTPUT WAS TRACED TO THE RF OUTPUT CABLE ASSEMBLY CENTER PIN WHICH WAS NOT MATING CORRECTLY WITH THE INSERT OF THE DSM CONNECTOR ON THE TWT. THE PROBLEM IS SIMILAR TO THAT REPORTED IN V76514 (REF. HUGHES MALFUNCTION REPORT 2329). THE RF CABLE ASSEMBLY PIN WAS NOT PROPERLY TAPERED OR CENTERED, AND UPON MATING HAD CAUGHT THE SLEEVING INSERT BENDING THE CORNER SLIGHTLY. THIS RESULTED IN AN INTERMITTENT CONDITION WHICH MADE THE RF OUTPUT UNSTABLE.

CORRECTIVE ACTION/COMMENTS.

CAUSE OF THIS DISCREPANCY WAS TEST SET-UP CONNECTORS DURING FINAL INTEGRATION. THIS TYPE OF FAILURE IS UNRELATED TO THE UNIT PERFORMANCE. THE TORQUE OF THESE CONNECTORS WILL BE VERIFIED BY INSPECTION. VISUAL CRITERIA AND DIMENSIONAL MEASUREMENT OF THE CENTER PINS WILL BE VERIFIED BEFORE MATING WHICH WILL BE INDICATED ON THE OPERATIONAL INSTRUCTION SHEET BY QUALITY CONTROL PERSONNEL. --- FOR ACTION: CLOSED 5-25-71.

workmanship
RF Conn

RELIABILITY ANALYSIS REPORT NUMBER V76514 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED 02-17-71
SYSTEM S N			TEST TYPE	QUALIFICATION	DATE CLOSED 04-27-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	TEMPERATURE	CRITICALITY BLANK
ORIGINATOR'S NAME	OSTA	AM	TEST PROCEDURE	QTPB200350	FAILURE CAUSE TEST EQUIPMENT
MFG CCC	VEND		PARAGRAPH NO.		RESPONSIBILITY TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION PLANNING CHANGE
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000	

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	007	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING QUALIFICATION TESTING, THERMAL-VACUUM ENVIRONMENT, WITH BASEPLATE TEMPERATURE AT 146 DEGREES F SMALL SIGNAL GAIN WAS NOT REPEATABLE (REF. HUGHES MALFUNCTION NOTIFICATION #2329).

FAILURE ANALYSIS.

THE PROBLEM OF NON-REPEATABLE SMALL SIGNAL GAIN WAS TRACED TO THE RF INPUT CONNECTION TO THE TWT WHICH WAS NOT TORQUED TO THE REQUIRED 8 INCH POUNDS. THIS RESULTED IN A VARIABLE INPUT VSWR WHICH AFFECTED THE REPEATABILITY OF THE SMALL SIGNAL GAIN MEASUREMENT. THE OSM RF CONNECTORS ARE EXTREMELY FRAGILE. IN THIS CASE THE CENTER CONDUCTOR OF THE COAX WIRE BECOMES THE CENTER PIN FOR THE MATING CONNECTOR. THIS WIRE (PIN) WAS TOO LONG CAUSING THE MATING CONNECTOR FEMALE PART TO BE PUSHED AWAY FROM THE CONNECTOR CAUSING INTERMITTENT CONNECTIONS.

CORRECTIVE ACTION/COMMENTS.

CAUSE OF THIS DISCREPANCY WAS TEST SET-UP CONNECTORS. THIS TYPE OF FAILURE IS UNRELATED TO THE POWER SUPPLY PERFORMANCE. THE TORQUE OF THESE CONNECTORS WILL BE VERIFIED BY INSPECTION AND VISUAL CRITERIA AND DIMENSIONAL MEASUREMENT OF THE CENTER PINS WILL BE VERIFIED BEFORE MATING WHICH WILL BE INDICATED ON THE OPERATIONAL INSTRUCTION SHEET BY QUALITY CONTROL PERSONNEL. --- FRB ACTION: CLOSED 4-27-71

workmanship RF Gain

RELIABILITY ANALYSIS REPORT NUMBER V76515 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	
SYSTEM S'N			TEST TYPE	QUALIFICATION	
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	AMBIENT	
ORIGINATOR'S NAME	ORTA	AM	TEST PROCEDURE	EQ4-664	
MFG CCC			PARAGRAPH NO.		
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000	

DATE INITIATED	02-18-71						
DATE CLOSED	03-23-71						
CRITICALITY	BLANK						
FAILURE CAUSE	DESIGN						
RESPONSIBILITY	TWT SUPPLIER						
CORRECTIVE ACTION	NONE REQUIRED						

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	007	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

HIGH LEVEL TWTA FAILED DURING QUALIFICATION TESTING. THIS THE SECOND FAILURE OF THIS QUAL. UNIT.

FAILURE ANALYSIS.

THIS FAILURE INVOLVED A CAPACITOR C5 IN THE BIAS CONVERTER AND A HIGH VOLTAGE CONVERTER TRANSISTOR Q6. THE CAPACITOR PROBLEM APPEARS TO HAVE BEEN ASSOCIATED WITH THE TEST SETUP. THE CHASSIS GROUND IN THE TEST EQUIPMENT WAS NOT CONNECTED TO THE POWER GROUND. AS A RESULT A REVERSE BIAS COULD HAVE RESULTED ACROSS THE CAPACITOR WHICH CAUSED ITS FAILURE. THE TRANSISTOR WAS SHORTED COLLECTOR TO EMITTER AND FURTHER INVESTIGATION SHOWED THE FLYBACK DIODE (CR16) LEAD WAS BROKEN. THE LATTER APPARENTLY OCCURRED DURING VIBRATION DUE TO LACK OF SUFFICIENT BOND BY THE CONFORMAL COATING BETWEEN THE GOLD WRAPPING AROUND THE DIODE AND THE PRINTED CIRCUIT BOARD. SUBSEQUENT TESTS SHOW THAT VOLTAGES WELL IN EXCESS OF THE RATED CAN APPEAR ACROSS THE COLLECTOR TO EMITTER OF THE TRANSISTOR WITH THE OPEN DIODE.

CORRECTIVE ACTION/COMMENTS.

CORRECTIVE ACTION IN THE CAPACITOR FAILURE WILL BE THE POSITIVE CONNECTION BETWEEN CHASSIS AND POWER GROUNDS ON ALL TEST EQUIPMENT AND INSTALLATION OF NON-POLARIZED CAPACITORS. CORRECTIVE ACTION IN THE TRANSISTOR FAILURE IS THAT ALL UNITS WILL HAVE THE GOLD WRAPPED DIODES SECURELY BONDED TO THE PRINTED CIRCUIT BOARD INSTEAD OF MERELY CONFORMALLY COATED. FRB ACTION: CLOSED 3-23-71.

Design Change
non H.V.

RELIABILITY ANALYSIS REPORT NUMBER V58621 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	08-18-70
SYSTEM S'N		TEST TYPE	BURN IN	DATE CLOSED	10-02-70
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	TEMPERATURE	CRITICALITY	BLANK
ORIGINATOR'S NAME	OSTA AM	TEST PROCEDURE	B200352-400	FAILURE CAUSE	DEFECTIVE PART
MFG CCC	VEND	PARAGRAPH NO.	5.2	RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	WONG N	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DRAWING REVISION
RESPONSIBLE ENGINEER	HILLARD W	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO. 310562	SERIAL NO. 008	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER	
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER	
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER	

DESCRIPTION OF FAILURE.

POWER SUPPLY B200352-120, S/N 008 MALFUNCTIONED DURING BURN-IN AFTER 300 HOURS OF OPERATION WHILE BEING TESTED IN ACCORDANCE WITH SPECIFICATION B 200352-400, PARAGRAPH 5.2. AN ARC OCCURRED BETWEEN THE ANODE AND CATHODE LEADS OF THE HIGH VOLTAGE MODULE, P/N B 200361-110, S/N 009.

FAILURE ANALYSIS.

OCCURRENCE OF THE ARC WAS VERIFIED BY VISUAL INSPECTION. THE ARC OCCURRED BETWEEN THE ANODE AND CATHODE LEADS OF THE HIGH VOLTAGE MODULE, BELOW THE SURFACE OF THE POTTING MATERIAL. THE ARC WAS CAUSED BY THE CLOSE PROXIMITY OF THE UNINSULATED PORTIONS OF THE ANODE AND CATHODE LEADS. THE LEADS HAD BEEN IMPROPERLY ROUTED DURING ASSEMBLY OR HAD MOVED DURING ENCAPSULATION SO THAT THEY APPEARED TO BE TOUCHING (REF. HUGHES MALFUNCTION REPORT 2309 AND TWX 910-347-6238)

CORRECTIVE ACTION/COMMENTS.

A DESIGN CHANGE HAS BEEN INCORPORATED WHICH ASSURES POSITIVE SEPARATION OF THE ANODE AND CATHODE LEADS (REF. ECN 813355). THE ECN BONDED A GLASS MOUNTING BOARD ON WHICH THE FEEDBACK RESISTORS ARE BONDED. THIS BOARD SEPARATES THE ANODE AND CATHODE LEADS. FURTHER STUDY OF THE GENERAL ARCING PROBLEM WILL BE DONE ON TDR #T58616. CLOSED AT 2 OCTOBER 1970 FRB.

RELIABILITY ANALYSIS REPORT NUMBER V65501 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	06-18-71
SYSTEM S/N		TEST TYPE	ACCEPTANCE	DATE CLOSED	08-26-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	DEFECTIVE PART
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	.	CORRECTIVE ACTION	PART PURGE
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO. 310542	SERIAL NO. 008	MANUFACTURER
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER

DESCRIPTION OF FAILURE.

DURING FUNCTIONAL TESTING OF HTWT, S/N 008, UNIT SHUT ITSELF OFF FOR NO APPARENT REASON ON SEVERAL OCCASIONS WHILE BEING TESTED IN ACCORDANCE WITH ATP B200350-450. ANOMALY FIRST OCCURRED AT END OF HTWT BURN-IN AND THEN REPEATED AT START OF ATP.

FAILURE ANALYSIS.

UNIT COULD NOT BE MADE TO REPEAT REPORTED FAILURE (DURING TROUBLESHOOTING TESTING). UNIT WAS MOUNTED IN THERMAL VACUUM CHAMBER AT AMBIENT PRESSURE AND OPERATED AT 146F BASEPLATE. UNIT WAS THEN VIBRATED IN THREE AXIS. UNIT WAS NEXT SUBJECTED TO THERMAL CYCLE BETWEEN 60F AND 146F AT AMBIENT PRESSURE AND THEN OPERATED ON THE LIFE TEST RACK FOR 300 HOURS. ALL OF THE TESTING WAS COMPLETED WITH NO ANOMALIES OR UNSCHEDULED SHUT DOWNS. UNIT WOULD NOT REPEAT REPORTED FAILURE. A CONTROLLED TEARDOWN ANALYSIS WAS NEXT CONDUCTED. UNIT WAS OPENED AND VISUALLY INSPECTED INCLUDING CONNECTIONS AND COMPONENTS. SEMICONDUCTOR MODULE GOLD WRAP WAS REMOVED AND CONNECTIONS INSPECTED. ISOLATORS AND CABLE ASSEMBLIES WERE REMOVED AND INSPECTED. NOTHING WHICH COULD HAVE CONTRIBUTED TO THE REPORTED FAILURE WAS OBSERVED.

CORRECTIVE ACTION/COMMENTS.

SINCE THE FAILURE MECHANISM COULD NOT BE IDENTIFIED OR REPEATED, NO SPECIFIC CORRECTIVE ACTION IS PLANNED. CONSULTATION BETWEEN TRW AND HAC/FED REPRESENTATIVES RESULTED IN THE AGREEMENT THAT THE REPORTED FAILURE COULD NOT BE REPEATED OR VERIFIED AND THE UNIT WOULD BE ACCEPTABLE AS LIFE TEST UNIT 22-3 IF THE FOLLOWING A WAS COMPLETED SUCCESSFULLY: (1) REMOVE TWT S/N 103 FROM TWTA; (2) REBUILD POWER SUPPLY B200352-120, S/N 33 TO PRINT; (3) SUBJECT POWER SUPPLY TO VACUUM SCREENING TEST OF B200352-400 FOLLOWED BY A MINIMUM 40 HOURS OF VACUUM BURN-IN FOLLOWED BY A FINAL SCREENING TEST PER B200352-400; (4) REBUILD TWTA TO PRINT WITH TWT S/N 201; (5) RETEST TWTA TO ATP B200350-400. UNIT SUCCESSFULLY COMPLETED ACCEPTANCE RETEST AND WAS SHIPPED 8/5/71.---FRB ACTION: CLOSED 20TH FRB, 8/26/71.

SN 008

C-27

RELIABILITY ANALYSIS REPORT NUMBER V76523 AG191 --- REPORT NO. 21 08-29-75

		TEST LEVEL	3	DATE INITIATED	03-15-71
		TEST TYPE	ACCEPTANCE	DATE CLOSED	04-27-71
		ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
	AM	TEST PROCEDURE	200350-401	FAILURE CAUSE	WORKMANSHIP
		PARAGRAPH NO.		RESPONSIBILITY	ESD ENGINEERING
	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
	R	CUM CYCLES	000		

	PART NO. 310542	SERIAL NO. 009	MANUFACTURER	HUGHES
	PART NO.	SERIAL NO.	MANUFACTURER	
	PART NO.	SERIAL NO.	MANUFACTURER	
	PART NO.	SERIAL NO.	MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING AND INTEGRATION OF THE HIGH LEVEL TWTA, S/N9, RF POWER WAS APPROXIMATELY 5 DB LOW. DC INPUT CURRENT WAS APPROXIMATELY LOW, SHOULD BE 3-4 AMPS WAS 2 AMPS.

FAILURE ANALYSIS.

ANALYSIS REVEALED THAT THE WRONG SIZE SCREWS HAD BEEN USED TO MOUNT THE TWT S/N 168 IN THE CHASSIS. THE SCREWS WERE TOO LONG AND WHEN TORQUED PUT EXCESSIVE STRAIN ON THE TWT CENTER. THE COLLECTOR END OF THE TWT VACUUM ENVELOPE IS HARD MOUNTED TO THE TWT HOUSING. THE EXCESSIVELY LONG SCREWS PUT SUFFICIENT STRAIN ON THE COLLECTOR CERAMIC TO CAUSE A SLIGHT LEAKAGE IN THE TWT VACUUM ENVELOPE.

CORRECTIVE ACTION/COMMENTS.

ASSEMBLY PERSONNEL HAVE BEEN INFORMED OF THIS PROBLEM AND CAUTIONED TO USE ONLY SCREWS ISSUED IN THE KIT. ALL SCREWS WHICH COULD BE USED TO MOUNT THE TWT HAVE BEEN PURGED FROM THE TWT BURN-IN AND INTEGRATION AREA. ALL COMPLETED TWTA'S AT TRW AS WELL AS HAC/EDD HAVE BEEN INSPECTED TO BE CERTAIN THE CORRECT MOUNTING SCREWS ARE INSTALLED. --- FRB ACTION: CLOSED 4-27-71.

workmanship
long screw

RELIABILITY ANALYSIS REPORT NUMBER V76534 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	04-08-71
SYSTEM S N			TEST TYPE	ACCEPTANCE	DATE CLOSED	05-25-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	DETA	AM	TEST PROCEDURE	B200350-400	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.	10.0 STEP 5	RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK	D	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	011	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING OF THE HTWT, THERMAL/VACUUM ENVIRONMENT, UNIT TURN-OFF BY OVERLOAD PROTECTION CIRCUIT AT END OF TIME DELAY. WOULD NOT RESTART. BASEPLATE TEMPERATURE WAS PLUS 100 DEGREES F. (REF HUGHES MALFUNCTION NOTIF. # 2338)

FAILURE ANALYSIS.

THE TWT AND POWER SUPPLY WERE DISCONNECTED. THE POWER SUPPLY WAS TESTED AND FOUND TO BE WITHIN SPECIFICATION. THE PROBLEM WAS TRACED TO TWT S/N 62. RESISTANCE BETWEEN BASEPLATE OF THE TWT AND THE COLLECTOR WAS ABOUT 10K OHMS (S/B GREATER THAN 10 GIGS-OHMS). CAREFUL REMOVAL OF THE TWT PACKAGE AND POTTING MATERIAL REVEALED AN ARC OCCURRED BETWEEN THE COLLECTOR AND TWT BASEPLATE. THE ARC WAS AT THE COLLECTOR ISOLATING CERAMIC SURFACE AND ITS INTERFACE WITH THE POTTING MATERIAL WHICH ENCLOSES THE COLLECTOR HOUSING. APPARENTLY DUE TO AN UNBONDED AREA IN THE POTTING INTERFACE. THE TWT WAS REWORKED TO PRINT, RETESTED, INTEGRATED WITH A POWER SUPPLY AND THE UNIT RETESTED OK.

CORRECTIVE ACTION/COMMENTS.

THIS IS THE ONLY CASE OF THIS TYPE OF FAILURE ON THE PROGRAM AND IS AN ISOLATED CASE. ASSEMBLY AND INSPECTION PERSONNEL HAVE BEEN INFORMED OF THIS FAILURE AND CAUTIONED TO EXERCISE CARE IN ASSEMBLY AND INSPECTION. --- FRB ACTION: CLOSED 5/25/71.

Shirt Tail collection

RELIABILITY ANALYSIS REPORT NUMBER V65504 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	06-18-71
SYSTEM S/N		TEST TYPE	ACCEPTANCE	DATE CLOSED	07-30-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	WORKMANSHIP
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME		CORRECTIVE ACTION	NONE IMPLEMENTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	013	MANUFACTURER
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

HTWT, S/N 013, MALFUNCTIONED DURING FUNCTIONAL TEST OF ATP B200350-400. UNIT WAS OUT OF SPECIFICATION. EXCESSIVE INPUT HOT AND COLD VSWR.

FAILURE ANALYSIS.

PROBLEM WAS TRACED TO INPUT CABLE AND ISOLATOR ASSEMBLY. THE CABLE AND ISOLATOR ASSEMBLY WAS REPLACED AND THE UNIT TESTED WITHIN SPECIFICATION WITH NO ANOMALIES. CABLE AND ISOLATOR ASSEMBLY CONSISTS OF NECESSARY RF CONNECTORS, COAX CABLE, AND ISOLATOR TO GO FROM CHASIS INPUT TO TWT INPUT CONNECTOR. REFERENCE HUGHES MALFUNCTION REPORT NO. 2346.

CORRECTIVE ACTION/COMMENTS.

HTWT, SERIAL NO. 013, WAS REWORKED TO PRINT BY REPLACING INPUT CABLE AND ISOLATOR ASSEMBLY. THE UNIT WAS RETESTED TO THE ACCEPTANCE TEST PROCEDURE WITH NO FURTHER ANOMALIES. THE INPUT CABLE AND ISOLATOR ASSEMBLY IS A PURCHASED ASSEMBLY AND CANNOT BE TESTED MEANINGFULLY FOR THE OUT-OF-SPEC CONDITION EXPERIENCED EXCEPT AT THE TWTA LEVEL. THE ISOLATOR WAS MOST PROBABLY AN OUT-OF-SPEC DEVICE AS RECEIVED FROM THE VENDOR. ALL TWTA'S ARE TESTED FOR HOT AND COLD VSWR AS PART OF THEIR ACCEPTANCE TESTING AND SUFFICIENT TESTING CURRENTLY EXISTS TO DETECT THIS FAILURE MECHANISM.

RELIABILITY ANALYSIS REPORT NUMBER V76533 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	04-08-71
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	05-25-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	DEPA	AM	TEST PROCEDURE	EQ4-664	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	014	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING OF THE HTWT, AMBIENT ENVIRONMENT, UNIT OVERCURRENTS AT END OF TIME DELAY. (REF HUGHES MALFUNCTION NOTIF #2337)

FAILURE ANALYSIS.

POWER SUPPLY WAS TESTED AND FOUND TO BE IN SPEC WITH NO ANOMALIES. TWT, S/N 165 WAS REMOVED AND FOUND TO HAVE A LEAK AT THE COLLECTOR CERAMIC. TWT WAS MOUNTED TO TWA CHASSIS WITH OVERSIZE SCREWS. --- IDENTICAL TO PROBLEM REPORTED IN HUGHES MALFUNCTION REPORT 2331. UNITS WERE INTEGRATED AT ABOUT THE SAME TIME.

CORRECTIVE ACTION/COMMENTS.

ASSEMBLY PERSONNEL WERE INFORMED OF THIS PROBLEM AND CAUTIONED TO USE ONLY SCREWS IN THE KIT. ALL SCREWS WHICH COULD BE USED TO MOUNT THE TWT HAVE BEEN PURGED FROM THE TWT BURN-IN AND INTEGRATION AREA. ALL COMPLETED TWTA'S AT TRW AND HAC/EDD HAVE BEEN INSPECTED TO BE CERTAIN THE CORRECT MOUNTING SCREWS ARE INSTALLED. --- FRB ACTION: CLOSED 5-25-71.

RELIABILITY ANALYSIS REPORT NUMBER V76744 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	11-14-70
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	DETA A	TEST PROCEDURE	TP8200352	FAILURE CAUSE	PROCESS
MFG CCC	VEND	PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	PROCESS CHANGE
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	015	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE LEVEL HIGH LEVEL POWER SUPPLY SPECIAL SCREENING BURN-IN, VACUUM BURN-IN, POWER SUPPLY WAS AT VACUUM FOR ABOUT 24 HOURS WHEN UNIT WAS OBSERVED "OFF". UNIT WOULD NOT RESPOND TO "ON" COMMAND.

FAILURE ANALYSIS.

INVESTIGATION FOUND THAT MAGNETIC AMPLIFIER T3 ARCED FROM HIGH VOLTAGE WINDINGS 3-4 TO 1-2. CAUSE OF THE ARC WAS FOUND TO BE A VOID IN THE POTTING AT A POINT BETWEEN WINDINGS 3-4 AND 1-2 REF. HUGHES MALFUNCTION NOTIFICATION #23171.

CORRECTIVE ACTION/COMMENTS.

HUGHES HAS REDESIGNED THE CIRCUIT TO REPLACE THE MAGNETIC AMPLIFIER WITH A CURREN TRANSFORMER, WHICH IS A TWO COIL DEVICE INSTEAD OF A THREE COIL DEVICE. THIS ALLOWS MUCH MORE ROOM FOR INSULATION BETWEEN HIGH AND LOW VOLTAGE WINDINGS.

Design Change

RELIABILITY ANALYSIS REPORT NUMBER V76763 AC121 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	12-09-70
SYSTEM S N			TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA	A	TEST PROCEDURE	TP8200352	FAILURE CAUSE	RELATED HARDWARE
MFG CCC	VEND		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TRUCK	R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	015	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING VACUUM BURN-IN TESTING OF THE HIGH LEVEL POWER SUPPLY, P/N B200352-120, S/N 015, CATHODE TELEMETRY IS OUT OF SPECIFICATION (SEE HUGHES MALFUNCTION NOTIFICATION #2321)

FAILURE ANALYSIS.

CATHODE TELEMETRY FAILURE WAS A SECONDARY FAILURE WHICH RESULTED FROM FAILURE OF T3 (SEE V76744). TELEMETRY FAILURE WAS DETECTED UPON REPLACEMENT OF T3 AND RETEST.

CORRECTIVE ACTION/COMMENTS.

CATHODE TELEMETRY HAS BEEN REDESIGNED TO ELIMINATE MAGNETIC AMPLIFIER APPROACH TO CATHODE TELEMETRY (SEE V76744).

Design Change
H V

RELIABILITY ANALYSIS REPORT NUMBER V76761 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	11-30-70
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA A	TEST PROCEDURE	TP8200352	FAILURE CAUSE	DEFECTIVE PART
MFG CCC	VEND	PARAGRAPH NO.	STEP 8	RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HPWT	PART NO. 310542	SERIAL NO. 016	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER	
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER	
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING HIGH LEVEL POWER SUPPLY, P/N B200352-120, S/N 016, SPECIAL SCREENING TEST 777-18(VACUUM BURN-IN), UNIT DREW HIGH CURRENT (REF. HUGHES MALFUNCTION NOTIFICATION #2319).

FAILURE ANALYSIS.

ANODE BRIDGE Z1 HAS TWO SHORTED DIODES. TRANSFORMER T1 HAS WINDINGS 1,2,3 SHORTED TO 4,5,6 AND 20,21.

CORRECTIVE ACTION/COMMENTS.

CIRCUIT DESIGN CHANGES TO BE INCORPORATED TO ELIMINATE TRANSIENT HIGH VOLTAGE SPIKES. ALSO, TEST PROCEDURE CHANGED TO ENSURE THAT THE HIGH VOLTAGE MODULE IS NEVER TESTED WHILE UNLOADED DURING VACUUM SCREEN TEST.

RELIABILITY ANALYSIS REPORT NUMBER V65505 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	06-18-71
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	07-30-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	WORKMANSHIP
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	.	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	016	MANUFACTURER	
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

HTWT, S/N 016, MALFUNCTIONED DURING THERMAL VACUUM TEST OF ATP 8200350-400, PARAGRAPH 10.0, STEP 3. SMALL SIGNAL GAIN WAS UNSTABLE AT + 60 DEGREES F IN THERMAL VACUUM.

FAILURE ANALYSIS.

PROBLEM WAS TRACED TO RF INPUT OF TWT. A SMALL SILVER FLAKE WAS FOUND ON THE WINDOW OF THE TWT RF INPUT. THE SOURCE OF THIS FLAKE WAS THE SILVER LOADED EPOXY USED TO HOLD THE MAGNETIC STACK IN PLACE. THE MOST PROBABLE WAY THE FLAKE GOT ON THE WINDOW WAS DURING ASSEMBLY AND TEST OF THE TUBE. DURING ASSEMBLY AND TEST THE TUNER ASSEMBLY IS MOUNTED AND REMOVED SEVERAL TIMES FOR NECESSARY RF TESTS PRIOR TO PACKAGING OF THE TWT. THE SILVER FLAKE APPARENTLY ADHERED TO THE INSIDE OF THE TUNER ASSEMBLY UPON REMOVAL OF THE TUNER ASSEMBLY AND ON A SUBSEQUENT MOUNTING IT FELL ONTO THE WINDOW. REFERENCE HUGHES MALFUNCTION REPORT NO. 2347. FOR REPORTS ON SIMILAR OCCURRENCES SEE TDR NO'S. V65503 AND V65506.

CORRECTIVE ACTION/COMMENTS.

THE UNIT WAS REWORKED TO PRINT BY REMOVING THE CONTAMINANT AND RETESTED SATISFACTORILY TO THE ACCEPTANCE TEST PROCEDURE. ASSEMBLY PERSONNEL HAVE BEEN CAUTIONED AND INSTRUCTED TO INSPECT THE TUNER ASSEMBLY FOR THIS CONDITION PRIOR TO MOUNTING. SUFFICIENT TESTING CURRENTLY EXISTS TO DETECT THIS FAILURE MECHANISM AS THE TWT PERFORMANCE IS SENSITIVE TO CONTAMINATION ON THE WINDOW.

Workmanship RF Cram

RELIABILITY ANALYSIS REPORT NUMBER V56197 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	09-16-70
SYSTEM S'N			TEST TYPE	BURN IN	DATE CLOSED	11-20-70
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	DRTA	AM	TEST PROCEDURE	8200302-400	FAILURE CAUSE	OPERATOR
MFG CCC	VEND		PARAGRAPH NO.	5.2	RESPONSIBILITY	T-W SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	HILLARD	W	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	017	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING BURN-IN OF HIGH LEVEL TWT POWER SUPPLY SERIAL NO. 017, P/N 8200352-120 PER HUGHES TEST PROCEDURE 8200302-400, PARAGRAPH 5.2, THE ANODE VOLTAGE DROPPED FROM 80 VOLTS TO 50 VOLTS. (REF. MALFUNCTION NOTIFICATION NO. 2314)

FAILURE ANALYSIS.

A BROKEN LEAD WAS FOUND AT TERMINAL 11 OF TRANSFORMER T-1, DUE TO REPEATED FLEXING OF THE LEAD DURING ASSEMBLY AND TEST.

CORRECTIVE ACTION/COMMENTS.

TEST PERSONNEL HAVE BEEN MADE AWARE OF THE POSSIBILITY OF DAMAGING THE WIRE AND HAVE BEEN CAUTIONED TO AVOID MOVING THE TELEMETRY BOARD DURING TEST CLOSED AT 20 NOVEMBER 1970 FRB

RELIABILITY ANALYSIS REPORT NUMBER V76768 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	12-16-70
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA A	TEST PROCEDURE	8200352-400	FAILURE CAUSE	DESIGN
MFG CCC	VEND	PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	018	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING, VACUUM BURN-IN, THE HIGH LEVEL POWER SUPPLY, P/N 8200352-12, HELIX CURRENT INDICATION WAS HIGH AND CATHODE VOLTAGE WAS LOW. ANODE BRIDGE IS SHORTED SIMILAR TO MALFUNCTION NOTIFICATIONS #2318 AND 2319 (REF. HUGHES MALFUNCTION NOTIFICATION #2325).

FAILURE ANALYSIS.

ANODE BRIDGE Z1 WAS SHORTED. TRANSFORMER T1 WINDINGS 12-13 OPEN. INTERNAL INVESTIGATION OF T1 INDICATED WINDINGS 4-5 OVERHEATED SIMILAR TO THAT OF V76749; HOWEVER, IN THIS CASE WINDING 12-13 OPENED DUE TO HEATING OF 4-5 BEFORE 4-5 OPENED.

CORRECTIVE ACTION/COMMENTS.

CIRCUIT DESIGN CHANGES TO BE INCORPORATED TO ELIMINATE TRANSIENT HIGH VOLTAGE SPIKES. ALSO, TEST PROCEDURE CHANGED TO ENSURE THAT THE HIGH VOLTAGE MODULE IS NEVER TESTED WHILE UNLOADED DURING VACUUM SCREEN TEST.

RELIABILITY ANALYSIS REPORT NUMBER V76764 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	
SYSTEM S'N			TEST TYPE	ACCEPTANCE	
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	AMBIENT	
ORIGINATOR'S NAME	ORTA	A	TEST PROCEDURE	TP8200352	
MFG CCC	VEND		PARAGRAPH NO.		
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000	

DATE INITIATED	11-24-70						
DATE CLOSED	01-22-71						
CRITICALITY	PLANK						
FAILURE CAUSE	DEFECTIVE PART						
RESPONSIBILITY	TRW SUPPLIER						
CORRECTIVE ACTION	NONE REQUIRED						

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	019	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING HIGH LEVEL POWER SUPPLY, P/N B200352-12, S/N 019, ACCEPTANCE TESTING EXCESSIVE RIPPLE ON THE CATHODE APPEARED (REF HUGHES MALFUNCTION NOTIFICATION #2322).

FAILURE ANALYSIS.

INDUCTOR L11 HAS TERMINATION SHORTED TO MOST OF ITS TURNS.

CORRECTIVE ACTION/COMMENTS.

INDUCTOR DESIGN IS BEING CHANGED.

RELIABILITY ANALYSIS REPORT NUMBER V76762 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	12-09-70
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	01-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA A	TEST PROCEDURE	TPB200352	FAILURE CAUSE	DEFECTIVE PART
MFG CCC	VEND	PARAGRAPH NO.		RESPONSIBILITY	ESD SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	DESIGN CHANGE
RESPONSIBLE ENGINEER	TRUCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	020	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING VACUUM BURN-IN THE HIGH LEVEL POWER SUPPLY P/N B200352-120, S/N 020, RIPPLE VOLTAGE ON CATHODE VOLTAGE EXCEEDS SPECIFICATION LIMIT OF 500 MV MAXIMUM. MEASURED VALUE IS 3 VOLTS. HIGH VOLTAGE MODULE, S/N 005 WAS REMOVED AND REPLACED. (REF HUGHES MALFUNCTION NOTIFICATION #2320).

FAILURE ANALYSIS.

FAILURE ANALYSIS BY HAC VERIFIED THAT INDUCTOR L11 HAD A LOW Q FACTOR AND LOW INDUCTANCE. A VISUAL INSPECTION DETECTED A HIGH VOLTAGE SHORT BETWEEN THE LEAD END AND THE 1157 INSULATING TAPE OPPOSITE THE CHOKE COILS EFFECTIVELY DEGRADING THE CHOKE FUNCTION WITHOUT AFFECTING DC RESISTANCE READINGS.

CORRECTIVE ACTION/COMMENTS.

THE INDUCTOR WAS REDESIGNED USING SEPARATE TERMINALS FOR WIRING ELIMINATING THE 1157 TAPE INTERFACE. THE NEW CHOKE P/N IS B850CCC-048 AND IS EFFECTIVE ON ALL UNITS

RELIABILITY ANALYSIS REPORT NUMBER V65506 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	06-18-71
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	07-30-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	WORKMANSHIP
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	.	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO. 310542	SERIAL NO. 020	MANUFACTURER
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER

DESCRIPTION OF FAILURE.

HTWT, S/N 020 MALFUNCTIONED DURING THERMAL VACUUM TEST OF ATP B200350-400, PARAGRAPH 10.0, STEP 6. SMALL SIGNAL GAIN GAIN WAS UNSTABLE AT + 146 DEGREES F IN THERMAL VACUUM.

FAILURE ANALYSIS.

A METAL SLIVER WAS FOUND IN THE INPUT RF CONNECTOR OF TWT. SLIVER HAD COME FROM THE PLATING ON THE THREADS OF THE FEMALE PART OF THE CONNECTOR AND WAS LYING IN A POSITION WHERE IT COULD SHORT THE RF INPUT. REFERENCE HUGHES MALFUNCTION REPORT NO. 2348. FOR REPORTS ON SIMILAR OCCURRENCES SEE TDP NO'S V65503 AND V65505.

CORRECTIVE ACTION/COMMENTS.

THE UNIT WAS REWORKED TO PRINT BY REMOVING THE CONTAMINANT AND WAS SUCCESSFULLY RETESTED TO THE ACCEPTANCE TEST PROCEDURE. SUFFICIENT TESTING CURRENTLY EXISTS TO DETECT THIS FAILURE MECHANISM. IN ADDITION, AS PART OF THE ASSEMBLY PROCEDURE, THE FEMALE PART OF THE CONNECTORS ARE CONNECTED AND DISCONNECTED TO A DUMMY MALE CONNECTOR SEVERAL TIMES AND THEN INSPECTED FOR LOOSE SLIVERS PRIOR TO FINAL INSTALLATION IN THE TWTA.

workmanship RF Conn

RELIABILITY ANALYSIS REPORT NUMBER V76543 AG191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	05-07-71
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	PROCEDURE
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	.	CORRECTIVE ACTION	NONE REQUIRED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	021	MANUFACTURER	
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING FUNCTIONAL TESTING OF THE HTWT, HOT OUTPUT MATCH IS OUT OF SPEC. REFLECTION COEFFICIENT IS 50 PERCENT, S/B 33 PERCENT MAXIMUM. (REF. HUGHES MALFUNCTION REPORT NO. 2341).

FAILURE ANALYSIS.

THE TWT S/N 138 WAS REMOVED FROM THE CHASSIS BUT NOT ELECTRICALLY DISCONNECTED IN ORDER TO GAIN ACCESS TO THE TUNER. REVIEW OF THE TUBE DATA INDICATED THE TWT REFLECTION COEFFICIENT TO BE 33 PERCENT. WHEN THE OUTPUT CABLE WAS ADDED AT INTEGRATION, THE REFLECTION COEFFICIENT WAS OUT OF SPECIFICATION BECAUSE NO ALLOWANCE WAS MADE FOR THE ADDITION OF THE OUTPUT CABLE. THIS IS A PROCEDURAL ERROR BECAUSE THE TWT WAS ACCEPTED FOR INTEGRATION WITH NO ALLOWANCE FOR CABLE CONTRIBUTION. THIS HAS NOT BEEN A PROBLEM TO DATE BECAUSE THE TWT REFLECTION COEFFICIENTS WERE LOW ENOUGH THAT AFTER INTEGRATION THE UNITS WERE ALWAYS WITHIN THE TWTA SPECIFICATION LIMITS. THE TUNER WAS REPLACED ON TWT S/N 138 AND A NEW OUTPUT CABLE ADDED. THE TWT WAS RETUNED TO MEET THE 33 PERCENT MAXIMUM REFLECTION COEFFICIENT. THE TWT WAS THEN RETESTED FOR HOT AND COLD MATCH AND SMALL SIGNAL GAIN WITH NO ANOMALIES. THE TWTA WAS RETESTED TO THE COMPLETE ATP AND RETESTED O.K.

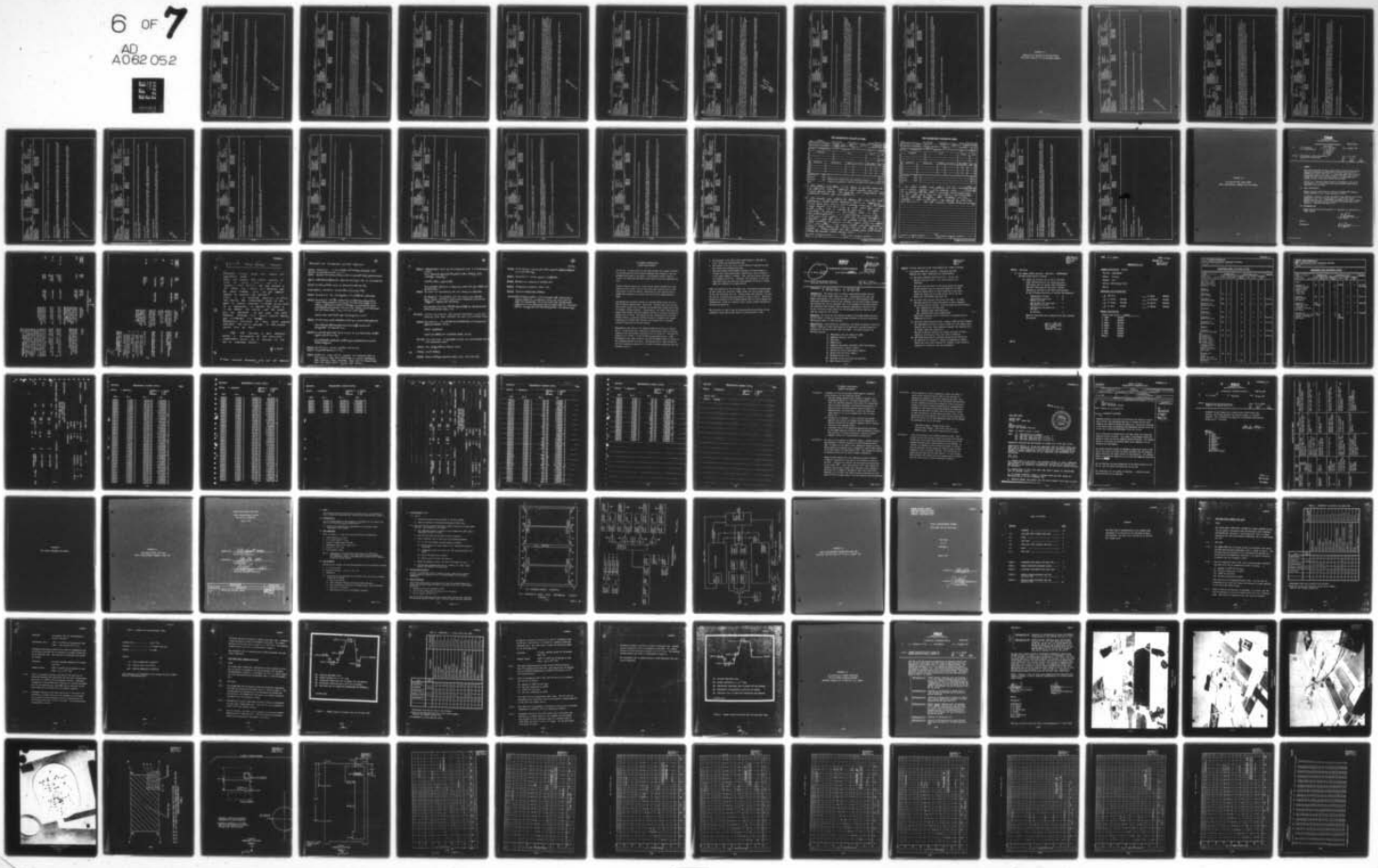
CORRECTIVE ACTION/COMMENTS.

THE INTEGRATION TEST WILL INCLUDE A TEST PRIOR TO ATP TO BE SURE THE REFLECTION COEFFICIENT OF THE TWT AND CABLE ARE WITHIN SPECIFICATION PRIOR TO SUBMITTAL TO ATP. NO TWTA'S CAN BE DELIVERED WHICH DO NOT MEET THE 33 PERCENT MAXIMUM REFLECTION COEFFICIENTS AS SPECIFIED IN THE ATP. FRB ACTION: CLOSED 6-22-71.

C-41

AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

6 OF 7
AD
A062 052



RELIABILITY ANALYSIS REPORT NUMBER V65502 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	06-18-71
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	DEFECTIVE PART
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME		CORRECTIVE ACTION	DRAWING REVISION
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO. 310542	SERIAL NO 021	MANUFACTURER
SUBASSEMBLY NAME		PART NO.	SERIAL NO.	MANUFACTURER
DETAIL SUBASSY		PART NO.	SERIAL NO.	MANUFACTURER
COMPONENT PARTS		PART NO.	SERIAL NO.	MANUFACTURER

DESCRIPTION OF FAILURE.

AFTER VIBRATION TEST OF ATP 8200350-400, SOMETHING WAS LOOSE INSIDE HTWT, S/N 021.

FAILURE ANALYSIS.

INVESTIGATION REVEALED THE LOCK WASHER AND NUT FROM THE CATHODE ACTIVITY PLUG STUD (J4) WAS LOOSE INSIDE HTWT, S/N 021. UNIT WAS REWORKED BY REMOVING THE STUD AND LOOSE NUT. THE STUD WAS THEN BONDED INTO THE CHASSIS PER ECN A8071. UNIT WAS THEN SUBJECTED TO VIBRATION TEST IN THREE AXIS AND RETESTED OK.

CORRECTIVE ACTION/COMMENTS.

DRAWING 8200352-120 WAS CHANGED BY ECN A8071 TO DELETE THE NUT AND LOCK WASHER, EFFECTIVE ON S/N 021, THEN S/N 045 AND UP. THE THREADED STUD IS NOW BONDED INTO THE CHASSIS PER HP16-99, TYPE 111 EPOXY. -- FRB ACTION: CLOSED 6-22-71.

Jose Landaverde

C-42

RELIABILITY ANALYSIS REPORT NUMBER V76543 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	05-07-71
SYSTEM S N		TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME		TEST PROCEDURE		FAILURE CAUSE	PROCEDURE
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	.	CORRECTIVE ACTION	NONE REQUIRED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES			

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	021	MANUFACTURER
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

DURING FUNCTIONAL TESTING OF THE HTWT, HOT OUTPUT MATCH IS OUT OF SPEC. REFLECTION COEFFICIENT IS 50 PERCENT, S/B 33 PERCENT MAXIMUM. (REF. HUGHES MALFUNCTION REPORT NO. 2341).

FAILURE ANALYSIS.

THE TWT S/N 138 WAS REMOVED FROM THE CHASSIS BUT NOT ELECTRICALLY DISCONNECTED IN ORDER TO GAIN ACCESS TO THE TUNER. REVIEW OF THE TUBE DATA INDICATED THE TWT REFLECTION COEFFICIENT TO BE 33 PERCENT. WHEN THE OUTPUT CABLE WAS ADDED AT INTEGRATION, THE REFLECTION COEFFICIENT WAS OUT OF SPECIFICATION BECAUSE NO ALLOWANCE WAS MADE FOR THE ADDITION OF THE OUTPUT CABLE. THIS IS A PROCEDURAL ERROR BECAUSE THE TWT WAS ACCEPTED FOR INTEGRATION WITH NO ALLOWANCE FOR CABLE CONTRIBUTION. THIS HAS NOT BEEN A PROBLEM TO DATE BECAUSE THE TWT REFLECTION COEFFICIENTS WERE LOW ENOUGH THAT AFTER INTEGRATION THE UNITS WERE ALWAYS WITHIN THE TWTA SPECIFICATION LIMITS. THE TUBE WAS REPLACED ON TWT S/N 138 AND A NEW OUTPUT CABLE ADDED. THE TWT WAS RETUNED TO MEET THE 33 PERCENT MAXIMUM REFLECTION COEFFICIENT. THE TWT WAS THEN RETESTED FOR HOT AND COLD MATCH AND SMALL SIGNAL GAIN WITH NO ANOMALIES. THE TWTA WAS RETESTED TO THE COMPLETE ATP AND RETESTED O.K.

CORRECTIVE ACTION/COMMENTS.

THE INTEGRATION TEST WILL INCLUDE A TEST PRIOR TO ATP TO BE SURE THE REFLECTION COEFFICIENT OF THE TWT AND CABLE ARE WITHIN SPECIFICATION PRIOR TO SUBMITTAL TO ATP. NO TWTA'S CAN BE DELIVERED WHICH DO NOT MEET THE 33 PERCENT MAXIMUM REFLECTION COEFFICIENTS AS SPECIFIED IN THE ATP. FRB ACTION: CLOSED 6-22-71.

C-41

RELIABILITY ANALYSIS REPORT NUMBER V76532 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	3	DATE INITIATED	04-06-71
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	TEMPERATURE	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA AM	TEST PROCEDURE	B200352-400	FAILURE CAUSE	WORKMANSHIP
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	TROCK R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO.	033	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING HTWT ACCEPTANCE TESTING AT -10 DEGREES F, CATHODE VOLTAGE WAS APPROX 2KV (S/B 3.8 KV). CATHODE VOLTAGE WAS WITHIN REQUIREMENTS AT ROOM AND HIGH TEMPERATURE. (REFERENCE HUGHES MALFUNCTION REPORT NO. 2335).

FAILURE ANALYSIS.

INVESTIGATION REVEALED THE BASE LEAD OF THE A SIDE OF Q5 (JANTX2N2920-DUAL TRANSISTOR) ON THE REGULATOR BOARD WAS INTERMITTENTLY TOUCHING THE GOLD WRAP AT COLD TEMPERATURE ONLY. CIRCUIT ANALYSIS VERIFIED THAT THE SHORTING OF THE A SIDE OF Q5 CAN IN NO WAY OVERLOAD ANY OTHER PART OF THE POWER SUPPLY. AFTER REWORK, THE UNIT WAS INSPECTED AND RETESTED TO THE POWER SUPPLY ATP WITH NO ANOMALIES. THE RETEST INCLUDED THE COLD TEMPERATURE START TEST.

CORRECTIVE ACTION/COMMENTS.

THIS IS AN ISOLATED CASE OF MARGINAL SEPARATION BETWEEN THE GOLD WRAP AND A LEAD PROTRUDING SLIGHTLY FROM THE FOAM MATERIAL. ASSEMBLY AND INSPECTION PERSONNEL WERE CAUTIONED TO EXERCISE MORE CARE IN ASSEMBLY AND INSPECTION. --- FRB ACTION: CLOSED 6-22-71.

Workmanship

RELIABILITY ANALYSIS REPORT NUMBER V76536 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	06-12-71
SYSTEM S/N			TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	TEMPERATURE	CRITICALITY	BLANK
ORIGINATOR'S NAME	ORTA	AM	TEST PROCEDURE	E200352-400	FAILURE CAUSE	DEFECTIVE PART
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	NONE REQUIRED
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	045	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

DURING ACCEPTANCE TESTING OF THE HTWT, AT PLUS 120 DEGREES F. ENVIRONMENT, ANODE VOLTAGE CHANGED FROM 233 VOLTS TO 248 VOLTS. ALL OTHER VOLTAGES NORMAL (REF HUGHES MALFUNCTION NOTIF. #2340).

FAILURE ANALYSIS.

INVESTIGATION SHOWED RESISTOR R3A IN THE ANODE VOLTAGE CIRCUIT IS OPEN. THIS TWTA IS THE ONLY ONE ON THE PROJECT WHICH REQUIRED AN ANODE VOLTAGE OF A MAGNITUDE REQUIRING 500K OHMS FOR RESISTORS R3-R3A (WHICH ARE SELECT-IN-TEST RESISTOR COMBINATION AND SELECTED IN ACCORDANCE WITH THE OPERATIONAL INSTRUCTION SHEET DEPENDING ON THE TWT ANODE VOLTAGE REQUIREMENT. ALL OTHER TWTA'S MECHANIZE THIS CIRCUIT FUNCTION UTILIZING RNC65 STYLE RESISTORS PER THE OIS. THE 500K OHMS FOR THIS UNIT WAS ACHIEVED WITH TWO CADDOCK 1 MEG RESISTORS WHICH WERE HARD-WIRED IN PARALLEL; HOWEVER, THE FOUR STAND-OFF TERMINALS ON TB4 ARE DESIGNED FOR THE RNC65 STYLE RESISTOR WHICH IS SHORTER THAN THE CADDOCK. IN ATTEMPTING TO FIT THE CADDOCK RESISTORS BETWEEN THE TERMINALS ON TB4, UNDUE STRAIN WAS APPLIED TO THE RESISTOR AND R3A OPENED. THE CIRCUIT WAS REWORKED TO PRINT AND IN ACCORDANCE WITH THE OPERATIONAL INSTRUCTION SHEET UTILIZING TWO RNC65 STYLE RESISTORS, 249 K EACH, WHICH WERE HARD-WIRED IN SERIES. THE UNIT RETESTED OK.

CORRECTIVE ACTION/COMMENTS.

ONLY RNC65 STYLE RESISTORS WILL BE USED TO MECHANIZE THIS SELECT-IN-TEST CIRCUIT FUNCTION. THIS IS THE FIRST AND LAST CASE OF ATTEMPTING TO USE THE CADDOCK RESISTORS TO ACHIEVE THIS CIRCUIT FUNCTION ON TB4. -- FRB ACTION: CLOSED 6-22-71.

RELIABILITY ANALYSIS REPORT NUMBER T64670 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	1	DATE INITIATED	07-09-73
SYSTEM S'N	3-3		TEST TYPE	ACCEPTANCE	DATE CLOSED	08-02-74
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY	MAJOR
ORIGINATOR'S NAME	ROUT	PA	TEST PROCEDURE	DR-21S-07K	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.	P 3.1	RESPONSIBILITY	ESD SUPPLIER
RELIABILITY ENGINEER	WAY	FE	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	SUPPLIER NOTIFIED
RESPONSIBLE ENGINEER	STEFISAND	JL	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542-001	SERIAL NO.	14-7	MANUFACTURER
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

DURING SATELLITE (F3) TESTING THE HIGH LEVEL TWT S/N 14-7 WAS NOTED TO HAVE A FILAMENT VOLTAGE OF 5.14 VDC FOR UP TO TWO HOURS AFTER TURN-ON. IT SHOULD BE 5.4 +/- 0.18 VDC. THE UNIT WAS REMOVED AND RETURNED TO THE VENDOR (HUGHES) ON NCMR J32701.

FAILURE ANALYSIS.

DETAILED TROUBLESHOOTING AND VISUAL EXAMINATION REVEALED A DEFECTIVE SOLDER JOINT AT PIN 9 OF THE HEATER POWER SUPPLY MODULE. NO CAUSE FOR THIS DEFECTIVE SOLDER JOINT COULD BE ESTABLISHED.

CORRECTIVE ACTION/COMMENTS.

THE DEFECTIVE SOLDER JOINT AND THE ADJACENT PIN (8) WERE REWORKED TO THE SPECIFICATION. THIS WAS IN ORDER TO ENSURE THE QUALITY OF THE SOLDER JOINTS IN THE HEATER MODULE.

Solder Joint

C-45

RELIABILITY ANALYSIS REPORT NUMBER V78310 AC171 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	07-26-73
SYSTEM S'N			TEST TYPE	ENG EVALUATION	DATE CLOSED	01-24-74
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	WAY	FE	TEST PROCEDURE		FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY	TRW SUPPLIER
RELIABILITY ENGINEER	WAY	FE	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	PROCESS CHANGE
RESPONSIBLE ENGINEER	STREISAND	JL	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542-001	SERIAL NO.	22-2	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

REFERENCE TELCON NOTIFICATION FROM HUGHES, HLTWTA UNIT S/N 22-2 UNDER SPECIAL LIFE TEST CEASED RF POWER OUTPUT AFTER 18,048 HOURS OF OPERATION.

FAILURE ANALYSIS.

EXTENSIVE TROUBLESHOOTING AND ANALYSIS BY HAC INCLUDING TWT LEAKAGE TESTING IDENTIFIED THE CAUSE OF FAILURE TO BE A FAULTY SPOTWELD OF THE TWT CATHODE HEATER FILIMENT WIRE. THE WIRE WAS FUSED OPEN IN THE UNCOATED SECTION ADJACENT TO A TERMINAL TAB. A METALLOGRAPHIC EXAMINATION WAS CONDUCTED ON THE WIRE INCLUDING USE OF THE SCANNING ELECTRON MICROSCOPE. THE GRAIN STRUCTURE VERIFIED AN OVERHEAT CONDITION AND A "NECKING DOWN" OF THE WIRE, BOTH PROBABLY FROM A FAULTY SPOTWELD. THIS DAMAGE WAS NOT EVIDENT FROM THE NORMAL 10X VISUAL INSPECTION. THERMAL STRESSING IN THE REDUCED SECTION FINALLY FAILED THE WIRE. THIS IS THE ONLY KNOWN FAILURE OF THIS KIND. (REFERENCE: HAC MALFUNCTION REPORT AND ANALYSIS NO. 2867)

CORRECTIVE ACTION/COMMENTS.

THIS UNIT HAS BEEN DELETED FROM THE LIFE TEST PROGRAM AND WILL NOT BE REPAIRED. HAC HAS INSTIGATED A LONG TERM DEVELOPMENT PROGRAM TO DEVELOP AN IMPROVED WELDING TECHNIQUE THAT IS INSPECTABLE TO DETECT SUCH CONDITIONS. CURRENTLY, INCREASED MAGNIFICATION TO 30X AND GREATER EMPHASIS ON THIS CONDITION CONSTITUTES CORRECTIVE ACTION FOR THIS PROBLEM.

RELIABILITY ANALYSIS REPORT NUMBER T64963 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777	TEST LEVEL	2	DATE INITIATED	01-07-72
SYSTEM S'N	3-6	TEST TYPE	ACCEPTANCE	DATE CLOSED	06-29-72
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	BLANK
ORIGINATOR'S NAME	NESBIT JM	TEST PROCEDURE	OP-065-02E	FAILURE CAUSE	09
MFG CCC	8228	PARAGRAPH NO.	2.1	RESPONSIBILITY	SVD MANUFACTURING
RELIABILITY ENGINEER	WAY FE	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	19
RESPONSIBLE ENGINEER	STREISAND	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542-002	SERIAL NO	24-13	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

N.C. ULTRA "B" WILL NOT SWITCH ON AFTER 90 SECONDS AND CAUSES THE SPACECRAFT TO UNDERVOLTAGE.

FAILURE ANALYSIS.

THE UNIT WAS RETURNED TO THE VENDOR (HUGHES) FOR FAILURE VERIFICATION AND ANALYSIS ON NCMR 51663. A GROSS LEAK WAS DETECTED AT THE TUBE COLLECTOR CERAMIC AND A HEATER OPEN INTERNAL TO THE TWT. ALL EVIDENCE INDICATES THE CAUSE OF FAILURE WAS A LONG SCREW BEING INSERTED INTO THE TWTA PACKAGE DURING SPACECRAFT INSTALLATION. THIS FRACTURED THE TWT VACUUM ENVELOPE AT THE COLLECTOR CERAMIC. OPERATING THE UNIT WITH LEAKAGE (LOSS OF VACUUM) FAILED THE HEATER DUE DUE EXPOSURE TO AIR. TRW IS PERFORMING SPECIAL TESTS (THERMAL CYCLING AND VIBRATION) ON THE F-5 AND F-6 UNITS AND THE TWO FLIGHT SPARES. THESE ARE SUSPECT BECAUSE OF IMPROPER INSTALLATION WITH LONG SCREWS. THE SPECIAL TESTING WILL VERIFY IF ANY OTHER UNITS WERE SUBJECTED TO SIMILAR DAMAGE.

CORRECTIVE ACTION/COMMENTS.

THE LONG SCREWS WERE USED DUE TO IMPROPER KITTING. AS A RESULT OTHER INSTALLATIONS WERE INSPECTED AND VERIFIED. THE KITS WERE ALSO VERIFIED FOR CORRECT SCREWS. THE SPECIAL TESTING HAS NOT INDICATED ANY CURRENT DEFICIENCIES BUT LONG TERM DEFECTS WILL BE DETECTED IF PRESENT AND DOCUMENTED ON SUBSEQUENT FAILURE REPORTS.

long screws @ 5/6

C-47

RELIABILITY ANALYSIS REPORT NUMBER V76522 AC191 --- REPORT NO. 21 08-29-75

PROJECT	P-777		TEST LEVEL	3	DATE INITIATED	03-05-71
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	06-22-71
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	BLANK
ORIGINATOR'S NAME	NEWMAN	AP	TEST PROCEDURE	FQ4-664	FAILURE CAUSE	SPECIFICATION
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY	ESD ENGINEERING
RELIABILITY ENGINEER	ALUMBAUGH	CA	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	NONE IMPLEMENTED
RESPONSIBLE ENGINEER	TROCK	R	CUM CYCLES	000		

ASSEMBLY NAME	HTWT	PART NO.	310542	SERIAL NO	24-2	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

UNIT WAS OUT OF SPECIFICATION IN FOUR AREAS. 1) INRUSH CURRENT AT THERMAL VACUUM PRIOR TO APPLICATION OF HIGH VOLTAGE SHOULD BE 15 AMPS MAX, IS 16 AMPS. 2) DC POWER AT THERMAL VACUUM SHOULD BE 103.0 WATTS, IS 103.82 WATTS. 3) SMALL SIGNAL GAIN SHOULD BE 54.0 DB MAX, IS 54.43 DB. 4) GAIN VARIATION (FLATNESS) SHOULD BE 0.35 DB MAX DURING THERMAL VACUUM IS 0.38 DB (REF. SIR #13201)

FAILURE ANALYSIS.

THIS UNIT ACCEPTED AS IS BY WAIVER 22-2 (CONTRACT P00083) ON NCMR NO. C48553.

CORRECTIVE ACTION/COMMENTS.

NONE REQUIRED

C-48

APPENDIX C-4

COMPILATION OF RELIABILITY ANALYSIS REPORT ON HLTWTA'S FROM THE 777 REPLENISHMENT PROGRAM

RELIABILITY ANALYSIS REPORT NUMBER V20320 AC191 --- REPORT NO. 21 03-25-77

PROJECT	777R		TEST LEVEL	3	DATE INITIATED	03-04-77
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	03-22-77
SUBSYSTEM NAME	COMMUN		ENVIRONMENT	AMBIENT	CRITICALITY	MINOR
ORIGINATOR'S NAME	HEILE	K	TEST PROCEDURE	B200350-410	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.	4.4	RESPONSIBILITY	ESC SUPPLIER
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	PROCEDURE REVISION
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000		

ASSEMBLY NAME	TWTA HL	PART NO.	310542-002	SERIAL NO	24-16	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

INRUSH CURRENT AT 5MS PAST HV TURN-ON S/B LESS THAN ISS+0.75A. UNIT READS +5.0A. AFTER 15MS, UNIT READS +4.0A. ALSO, TIME INTERVAL OF CURRENT IN EXCESS OF ISS IN ANY 5MSEC S/B 30 MA/SEC MAX. IS 40MA/SEC.

FAILURE ANALYSIS.

C6 AND C7 CAPACITORS IN THE POWER CONDITIONER WERE INTERCHANGED DURING ASSEMBLY.

CORRECTIVE ACTION/COMMENTS.

ASSEMBLY & INSPECTIONED PERSONNEL WERE ADVISED OF THE OVERSIGHT AND CAUTIONED. A TEST OF INRUSH CURRENT AT THE POWER CONDITIONER LEVEL OF ASSEMBLY WAS ADDED.

workmanship/test

RELIABILITY ANALYSIS REPORT NUMBER T64876 AC191 --- REPORT NO. 21 03-25-77

PROJECT	777K	TEST LEVEL	2	DATE INITIATED	07-28-76
SYSTEM S/N	3-7	TEST TYPE	INTEGRATION	DATE CLOSED	12-16-76
SUBSYSTEM NAME	COMM & CONT	ENVIRONMENT	AMBIENT	CRITICALITY	MINOR
ORIGINATOR'S NAME	ROSE PK	TEST PROCEDURE	DR-GOS-C4E	FAILURE CAUSE	RELATED HARDWARE
MFG CCC		PARAGRAPH NO.	STEP 144	RESPONSIBILITY	SSD TEST
RELIABILITY ENGINEER	HENRICH RJ	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	NONE REQUIRED
RESPONSIBLE ENGINEER	ANDERSON RH	CUM CYCLES	000		

ASSEMBLY NAME	DESPIN ASSY	PART NO.	310511-005	SERIAL NO	3-7	MANUFACTURER
SUBASSEMBLY NAME	LL TWTA	PART NO.	310514-001	SERIAL NO.	14-1	MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

DURING AMBIENT INTEGRATION TESTS, IT WAS NOT POSSIBLE TO PERFORM FREQUENCY RESPONSE SWEEPS OF CHANNEL 1A. ALSO NO OUTPUT POWER FROM LL TWTA @ POS "B".

FAILURE ANALYSIS.

THIS TWTA IS NON-FLIGHT HARDWARE; IT IS AN ASSY THAT WAS TRANSFERRED FROM THE PREVIOUS CONTRACT TO THE EXISTING CONTRACT, AND CLASSIFIED AS A "NON-FLIGHT SPARE" (REF DD1149 NO 75-PM 120) ON 17 SEPT 1975. IT WAS PLACED ABOARD S/C F7 ONLY TO ASSIST IN INITIAL I & T TESTS, HOWEVER, THE FACT THAT IT WAS RETURNED TO TRW FROM THE SUBCONTRACTOR WITH THE POWER SUPPLY DISCONNECTED FROM THE TUBE INTERNALLY WAS NOT KNOWN TO THE S/C TEST CONDUCTOR. (PREVIOUS FAILURE HISTORY WAS THE FAILURE TO TURN ON, AND WHEN INVESTIGATING THIS DEFECT, THE ASSY WAS INADVERTENTLY EXPOSED TO A HIGH TEMPERATURE (+80 DEG. C, INSTEAD OF +80 DEG. F) BY THE SUBCONTRACTOR. THE SUBCONTRACTOR HAD DEMATED THE TWT & P.S. FOR THIS INVESTIGATION AND RETURNED THE ASSEMBLY TO TRW WITHOUT RESTORING THE ELECTRICAL CONNECTIONS. THE CAUSE OF THE INITIAL FAILURE (FAILURE TO TURN-ON) WAS NEVER ISOLATED.

CORRECTIVE ACTION/COMMENTS.

S/N 14-1 TWTA WAS REMOVED FROM THE S/C AND RETURNED TO INTEGRATION STORES AS NON-FLIGHT HARDWARE. NO FURTHER CORRECTIVE ACTION IS PLANNED. NO OVERSTRESS OCCURRED AS A RESULT OF THE POWERING ON OF THE NON-FLIGHT ASSY.

RELIABILITY ANALYSIS REPORT NUMBER T21001 AC191 --- REPORT NO. 21 03-25-77

PROJECT	777K		TEST LEVEL	1	DATE INITIATED	09-24-76	
SYSTEM S'N	3-9		TEST TYPE	ACCEPTANCE	DATE CLOSED	12-22-76	
SUBSYSTEM NAME	COMM & CONT		ENVIRONMENT	AMBIENT	CRITICALITY	MAJOR	
ORIGINATOR'S NAME	ROSE	PR	TEST PROCEDURE	DR-005-04E	FAILURE CAUSE	WORKMANSHIP	
MFG CCC			PARAGRAPH NO.	STEP 286	RESPONSIBILITY	TRW SUPPLIER	
RELIABILITY ENGINEER	HENRICH	RJ	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	RECERTIFICATION	
RESPONSIBLE ENGINEER	JACKSON	WE	CUM CYCLES	000			

ASSEMBLY NAME	DESPUN ASSY	PART NO.	310511-005	SERIAL NO.	3-6	MANUFACTURER
SUBASSEMBLY NAME	HLTWT ASSY	PART NO.	310542-002	SERIAL NO.	24-17	MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

DURING AMBIENT INTEGRATION TESTS, INTERMITTENT GAIN CHANGE WAS NOTED ON CHANNELS 3 & 4 OF APPROX 0.75 DB BELOW NORMAL - NG HLTWTA FLT 3-6.

FAILURE ANALYSIS.

THE HLTWTA WAS RETURNED TO THE SUPPLIER (HUGHES ELECTRON DYNAMICS DIVISION) FOR INVESTIGATION. AFTER REMOVAL FROM THE POWER SUPPLY, THE RF CONNECTORS OF THE TWT (S/N 469) WERE X-RAYED WHILE ON THE TUBE. THE X-RAY SHOWED PARTICLES BETWEEN THE OUTER SURFACE OF THE INPUT MATCH PIPE AND THE INPUT CONNECTOR. THE TWT WAS SUBJECTED TO RF TESTING AND DEMONSTRATED FLUCTUATIONS IN OUTPUT POWER (PLUS / MINUS 0.3 DBM). UPON REMOVAL OF THE INPUT CONNECTOR, PARTICLES OF POTTING MATERIAL WERE OBSERVED ADHERING TO THE OUTER SURFACE OF THE MATCH PIPE. THE MATCH PIPE WAS CLEANED WITH 500 GRIT PAPER AND ALCOHOL. SUBSEQUENT RF TESTING OF THE REASSEMBLED UNIT DEMONSTRATED A STABLE RF OUTPUT.

CORRECTIVE ACTION/COMMENTS.

ALL TWTAS, LL & HL FOR F7 & F8, WERE THEN RECYCLED TO CHECK FOR THIS FAULT. S/N 24-17 HL TWTA WAS THE ONLY ASSEMBLY THAT DEMONSTRATED THE SYMTONS OF THE CONTAMINATION PROBLEM.

RF Rose

RELIABILITY ANALYSIS REPORT NUMBER V20324 AC191 --- REPORT NO. 21 04-15-77

PROJECT	777R		TEST LEVEL	3	DATE INITIATED	10-12-76	
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	03-29-77	
SUBSYSTEM NAME	COMM		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	MAJOR	
ORIGINATOR'S NAME	HEILE	R	TEST PROCEDURE	B200300-410	FAILURE CAUSE	DEFECTIVE PART	
MFG CCC			PARAGRAPH NO.	4.3	RESPONSIBILITY	ESD SUPPLIER	
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	FAILURE HISTORY SEAR	
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000			

ASSEMBLY NAME	TWTA LL	PART NO.	310541-001	SERIAL NO	14-19	MANUFACTURER	HUGNES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

TIME INTEGRAL OF CURRENT IN EXCESS OF ISS, "S/b" 0.0037 A-SEC MAX. "IS" 0.0040 A-SEC IN INITIAL FUNCTIONAL, AND 0.0049 A-SEC IN T/V.

FAILURE ANALYSIS.

PROBLEM WAS ISOLATED TO THE POWER CONDITIONER. POWER CONDITIONER WAS REPLACED AND UNIT PASSED ATP. FAILURE ANALYSIS OF THE POWER CONDITIONER ISOLATED THE PROBLEM TO A DEFECTIVE SEMICONDUCTOR MODULE #9. CAUSE OF THE MODULE-LEVEL DEFECT WAS NOT FOUND (MODULE WAS SCRAPPED).

CORRECTIVE ACTION/COMMENTS.

NONE REQUIRED. PROBLEM ISOLATED ONLY TO MODULE-LEVEL, HOWEVER, HISTORY SEARCH SHOWS NO OTHER INSTANCES OF A DEFECT REQUIRING REPLACEMENT OF THE EPC FOR THE 30 TUBES DELIVERED TO DATE ON 777R. WILL BE TREATED AS A RANDOM OCCURRENCE PENDING REPEATS.

RELIABILITY ANALYSIS REPORT NUMBER V20323 AC191 --- REPORT NO. 21 04-15-77

PROJECT	777R	TEST LEVEL	3	DATE INITIATED	10-21-76
SYSTEM S'N		TEST TYPE	ACCEPTANCE	DATE CLOSED	03-24-77
SUBSYSTEM NAME	COMM	ENVIRONMENT	AMBIENT	CRITICALITY	MAJOR
ORIGINATOR'S NAME	HEILE R	TEST PROCEDURE	RETEST	FAILURE CAUSE	DEFECTIVE PART
MFG CCC		PARAGRAPH NO.		RESPONSIBILITY	ESD SUPPLIER
RELIABILITY ENGINEER	HEILE R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	FAILURE HISTORY SEAR
RESPONSIBLE ENGINEER	HALBIRT C	CUM CYCLES	000		

ASSEMBLY NAME	TWTA LL	PART NO.	310541-001	SERIAL NO.	14-18	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS	DIODE	PART NO.	JAN TXV1N756A	SERIAL NO.		MANUFACTURER	MOTOROLA

DESCRIPTION OF FAILURE.

DURING TESTING, AFTER REWORK (REWORK CONSISTING OF CLEANING TWT WINDOW MATCH PIPE), NO HELIX TELEMETRY WAS PRESENT AT THE (POST CLEANING) SWEEP TEST.

FAILURE ANALYSIS.

VR-1 DIODE, JAN TXV1N756A, WAS FOUND TO BE CAUSING THE DISCREPANCY. REMOVAL AND REPLACEMENT OF THE DIODE CLEARED THE DISCREPANCY. DURING REMOVAL OF THE DIODE FOR FAILURE ANALYSIS, THE PART (WHICH WAS BONDED DOWN) WAS DESTROYED.

CORRECTIVE ACTION/COMMENTS.

PART-LEVEL FAILURE ANALYSIS WAS PRECLUDED BY THE DESTRUCTION OF THE DIODE DURING REMOVAL. A CHECK OF DPA RECORDS SHOWED NO ABNORMALITIES. NO OTHER PROBLEMS WERE EXPERIENCED WITH THIS PART DURING ASSEMBLY OF 30 TUBES TO DATE.

part

C-54

RELIABILITY ANALYSIS REPORT NUMBER V20322 AC191 --- REPORT NO. 21 03-25-77

PROJECT	777R		TEST LEVEL	3	DATE INITIATED	11-08-76
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	03-22-77
SUBSYSTEM NAME	COMM		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	MAJOR
ORIGINATOR'S NAME	HEILE		TEST PROCEDURE	B200300-410	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.	10	RESPONSIBILITY	ESD SUPPLIER
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000		

ASSEMBLY NAME	TWTA LL	PART NO.	310541-001	SERIAL NO	14-20	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

IN THERMAL VACUUM TEST, SMALL SIGNAL GAIN CHANGE FROM 90 F TO 130 F SHOULD BE 0.40DB MAX; IS 0.563DB. ALSO, GAIN F1 TO F2 SHOULD BE 0.275 DB MAX; IS 0.325 DB. GAIN IS ALSO SLIGHTLY LOW WITH 23 VDC, 28 VDC, & 23 VDC APPLIED.

FAILURE ANALYSIS.

CAUSE IS DAMAGED CENTER PIN OF TWT OUTPUT CONNECTOR DUE TO STRAIN FROM CIRCULATOR.

CORRECTIVE ACTION/COMMENTS.

REPLACED CIRCULATOR AND CENTER PIN OF TWT OUTPUT CONNECTOR. DISCUSSED INSTALLATION OF CIRCULATORS WITH ASSEMBLY SUPERVISOR. SEE V20321 FOR SIMILAR DISCREPANCY ON ANOTHER TUBE ON THE SAME DAY.

RF Comm

RELIABILITY ANALYSIS REPORT NUMBER V20321 AC191 —— REPORT NO. 21 03-25-77

PROJECT	777R		TEST LEVEL	3	DATE INITIATED	11-08-76
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED	03-22-77
SUBSYSTEM NAME	COMM		ENVIRONMENT	THERMAL VACUUM	CRITICALITY	MINOR
ORIGINATOR'S NAME	HEILE	R	TEST PROCEDURE	B200300-410	FAILURE CAUSE	WORKMANSHIP
MFG CCC			PARAGRAPH NO.	10	RESPONSIBILITY	LSD SUPPLIER
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000		

ASSEMBLY NAME	TWTA LL	PART NO.	310541-002	SERIAL NO.	24-20	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER	

DESCRIPTION OF FAILURE.

IN THERMAL VAS, SMALL SIGNAL GAIN BETWEEN STEP 5 AND STEP 6 SHOULD BE NO GREATER THAN 0.15 DB PER 15 F. IS 0.168 DB PER 15 F.

FAILURE ANALYSIS.

PROBLEM CAUSED BY STRAIN ON THE TWT OUTPUT CONNECTOR DURING INSTALLATION OF CIRCULATOR.

CORRECTIVE ACTION/COMMENTS.

TWTA WAS REWORKED (OUTPUT CONNECTOR). THE MATTER WAS DISCUSSED WITH THE ASSEMBLY SUPERVISOR REGARDING CARE NECESSARY IN THE INSTALLATION OF THE CIRCULATORS. SEE V20322 FOR A SIMILAR DISCREPANCY OCCURRING TO ANOTHER TUBE ON THIS SAME DATE.

RF comm

RELIABILITY ANALYSIS REPORT NUMBER V20325 AC191 --- REPORT NO. 21 05-06-77

PROJECT	777R		TEST LEVEL	3	
SYSTEM S'N			TEST TYPE	ACCEPTANCE	
SUBSYSTEM NAME	COMM		ENVIRONMENT	THERMAL VACUUM	
ORIGINATOR'S NAME	HEILE	R	TEST PROCEDURE	B200350-410	
MFG CCC			PARAGRAPH NO.	PARA10.STEP6	
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000	

DATE INITIATED	12-30-76						
DATE CLOSED	05-03-77						
CRITICALITY	MINOR						
FAILURE CAUSE	PROCESS						
RESPONSIBILITY	ESD SUPPLIER						
CORRECTIVE ACTION	EMPLOYEE INSTRUCTED						

ASSEMBLY NAME	TWTA HL	PART NO.	310542-002	SERIAL NO.	24-22	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS	RESISTOR, MF	PART NO.	RNC65	SERIAL NO.	N/A	MANUFACTURER	MEPCO

DESCRIPTION OF FAILURE.

WITH MAX. HELIX CURRENT, PRIMARY POWER SHOULD BE 105W MAX. UNIT READS 106.69 WAT 146 F TEMP EXPOSURE.

FAILURE ANALYSIS.

PROBLEM WAS TRACED TO INADEQUATE SELECTION OF SIT RESISTOR R7. UNIT WAS WITHIN SPEC AT AMBIENT TEMP. BUT OUT-OF-SPEC IN T/V AT 146 F.

CORRECTIVE ACTION/COMMENTS.

RESISTOR R7 WAS RESELECTED AND UNIT PASSED T/V. EMPLOYEE NOTIFIED OF FAILURE CAUSE. CLOSED AT FRB #27, 05-03-77.

RELIABILITY ANALYSIS REPORT NUMBER TZ1118 AC191 --- REPORT NO. 21 03-23-77

PROJECT	777K		TEST LEVEL	1	DATE INITIATED	02-09-77
SYSTEM S'N	3-7		TEST TYPE	ACCEPTANCE	DATE CLOSED	03-22-77
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY	MINOR
ORIGINATOR'S NAME	RAEL	J	TEST PROCEDURE	DR-065-036	FAILURE CAUSE	PROCEDURE
MFG CCC			PARAGRAPH NO.	3.0	RESPONSIBILITY	SSD TEST
RELIABILITY ENGINEER	HENRICH	RJ	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	PROCEDURE REVISION
RESPONSIBLE ENGINEER	ANDERSON	RM	CUM CYCLES	000		

ASSEMBLY NAME	SATELLITE	PART NO.	310503-005	SERIAL NO.	3-7	MANUFACTURER
SUBASSEMBLY NAME	LLTWTA	PART NO.	310541-001	SERIAL NO.	14-17	MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

DURING THE CATHODE ACTIVITY TEST, PER T/P DR-065-03C, PAGE 15, STEP 24, THE TUBE WAS COMMANDED ON WITH THE CA TEST BOX SWITCH IN THE OFF POSITION (FOR 10 MINUTES). THIS WAS THE EC LLTWTA 1 ASSY.

FAILURE ANALYSIS.

THE TWTA MANUFACTUREK WAS CONTACTED IN REGARD TO THIS INADVERTENT TURN ON OF THE TWTA, WITH THE SPECIAL CATHODE ACTIVITY TEST SWITCH IN THE "CA TEST" POSITION. MR. HARRINGTON OF HUGHES ELECTRON DYNAMICS DIV. STATED THAT NO DAMAGE OR DEGRADATION HAD OCCURRED AS A RESULT OF THIS EVENT, HOWEVER, IT WAS RECOMMENDED THAT TRW USE THE PROPER TURN ON SEQUENCE FOR THE "CA" TEST. (REF. TWX NO. 910-347-6238, FROM HUGHES/HEDD TO T. KEITEN OF TRW, DATED 10 JAN 77).

CORRECTIVE ACTION/COMMENTS.

PCU D-1 WAS INITIATED TO CORRECT THE TEST PROCEDURE. NO OTHER CORRECTIVE ACTION DEEMED NECESSARY.

C-58

RELIABILITY ANALYSIS REPORT NUMBER T20523 AC191 --- REPORT NO. 21 04-08-77

PROJECT	777R	TEST LEVEL	1	DATE INITIATED	03-20-77
SYSTEM S/N	3-8	TEST TYPE	ACCEPTANCE	DATE CLOSED	04-05-77
SUBSYSTEM NAME	COMM	ENVIRONMENT	BLANK	CRITICALITY	MAJOR
ORIGINATOR'S NAME	MCCOY EL	TEST PROCEDURE	DR-215-14K	FAILURE CAUSE	WORKMANSHIP
MFG CCC		PARAGRAPH NO.	3-3-1	RESPONSIBILITY	SSD SUPPLIER
RELIABILITY ENGINEER	FOWLER P	CUM OPERATING TIME	H0378.3	CORRECTIVE ACTION	CAR INITIATED
RESPONSIBLE ENGINEER	HALBIRT C	CUM CYCLES	000		

ASSEMBLY NAME	HLTWTA	PART NO.	310542-001	SERIAL NO.	14-15
SUBASSEMBLY NAME		PART NO.		SERIAL NO.	MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.	MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.	MANUFACTURER

DESCRIPTION OF FAILURE.

ATTEMPTING TO PERFORM FREQUENCY RESPONSE TEST 3.3.1 OF DR-215-14U STEP 29, HLTWTA DOES NOT TURN ON

FAILURE ANALYSIS.

HLTWTA SUPPLY FUZES FOUND BLOWN. TROUBLESHOOTING AMPLIFIER AT HUGHESFOUND TEFLON WIRE NAS 703-24-AC-92 SUPPLYING 5V BIAS TO Q8 (REGULATOR) BASE DRIVE WAS TRAPPED IN SCM ASSEMBLY AND HAD SHORTED TO FRAME. EFFORT WAS TO TURN Q8 FULL ON INTO EFFECTIVE SHORT, DESTROYING PART. FUZOS BLEW WHEN Q8 SHORTED. NO S/C OVERSTRESS OCCURRED REF DSCS-CIB-121.

CORRECTIVE ACTION/COMMENTS.

NO MORE OF THIS AMPLIFIER ARE TO BE PROCURRED FOR 777. CAR PREPARED REQUESTING HUGHES ADD BONDING AND TYING TO WIRING TO PRCLLUDE PROBLEM ON OTHER 777 TWTA'S. UNITS DELIVERED TO BE X-RAYED TO GAIN CONFIDENCE THIS WAS ISOLATED PROBLEM. CLOSED BY FRB 26

workmanship

C-59

RELIABILITY ANALYSIS REPORT NUMBER T21138 AC191 — REPORT NO. 21 04-22-77

PROJECT	777R		TEST LEVEL	2	DATE INITIATED	03-24-77
SYSTEM S'N	3-9		TEST TYPE	INTEGRATION	DATE CLOSED	- -
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY	MINOR
ORIGINATOR'S NAME	MCCOY	EL	TEST PROCEDURE	DR-005-04E	FAILURE CAUSE	UNDER INVESTIGATION
MFG CCC			PARAGRAPH NO.		RESPONSIBILITY	ESU SUPPLIER
RELIABILITY ENGINEER	HENRICH	RJ	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	UNDER INVESTIGATION
RESPONSIBLE ENGINEER	HALBIRT	CD	CUM CYCLES	000		

ASSEMBLY NAME	DESPUN ASSY	PART NO.	310511-005	SERIAL NO.	3-9	MANUFACTURER
SUBASSEMBLY NAME	HLTWTA	PART NO.	310542-001	SERIAL NO.	14-20	MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

GAIN FLATNESS VARIES APPROX. 0.7 DB DURING 60 MINUTE WARM-UP OF HIGH LEVEL TWTA.

RF Power

C-60

TEST DISCREPANCY FOLLOW-UP SHEET

PROJECT 777R PAGE 1 OF 2 DATE OF FAILURE _____ REPORT NO. T2113 8

21 FAILURE CAUSE: NORM. PERF. 30 CODE: 26 CRITICALITY 32 CODE RESPONSIBILITY 34 CODE CORRECTIVE ACTION: REJCT 35 CODE: 2

37 RELEVANT FAILURE (Y) YES (N) NO

HARDWARE NAME	PART NO.	SERIAL NO.	I.D. CODE
			H, T, W, T

6	COMPONENT NAME	COMPONENT PART NO.	DATE CODE OR S/N	MANUFACTURER'S NAME	PART TYPE CODE	DEFECT CODE	FAR NUMBER	FV	PT
1									
2									
3									
4									

DESCRIPTION OF FAILURE SUMMARY

FAILURE ANALYSIS SUMMARY: SENS. TO PRESSURE ON OUTPUT CABLE

CORRECTIVE ACTION SUMMARY: INPUT & OUTPUT CENTER CONDUCTORS REPLACED

DETAIL:

31 Gain flatness varies approx. 0.7 DB during 60 minute warm-up of high level TWTA. (Although this variation did not exceed specified limits, the assembly was dispositioned to be returned to vendor for investigation.)

33 The assembly was returned to Hughes EDD where the exact phenomenon could not be reproduced, that is a "clagging" of small signal gain at F1 and F0 during warm up. A slight overall increase (0.2 to 0.3 DB) of small signal gain was noted within 5 to 10 minutes of turn-on. A slight sensitivity to pressure on the output cable vs. gain also seemed apparent. As a precautionary measure, the center pins were replaced in both the input and output connector. When the unit was retested on the bench, a strong sensitivity to pressure on the input cable vs. output R-F was noted. The input isolator was then found to have a crack between the RG141 cable and the body of the isolator. Evidence indicates that the isolator joint was cracked during the connector rework described above.

E,C TDR NUMBER CP C DE NO. CHANGE INFO E,C TDR NUMBER CP C DE NO. CHANGE INFO

1 2 3 4 5 6 7 8 9

TEST DISCREPANCY FOLLOW-UP SHEET

PROJECT _____ PAGE 2 OF 2 DATE OF FAILURE _____ REPORT NO. T2-11-38

	HARDWARE NAME	PART NO.	SERIAL NO.	I.D. CODE
23				
24				
25				

6	COMPONENT NAME	COMPONENT PART NO.	DATE CODE OR S/N	MANUFACTURER'S NAME	PART TYPE CODE	DEFECT CODE	FAR NUMBER	FV	FT
26	1								
27	2								
28	3								
29	4								

30 DESCRIPTION OF FAILURE SUMMARY

32 FAILURE ANALYSIS SUMMARY

34 CORRECTIVE ACTION SUMMARY

DETAIL:

35 The input isolator was replaced and the assembly then operated in a normal manner. The assembly was subjected to a special stability test (measuring small signal gain vs time, after having been off for over-night) and subjected to an abbreviated acceptance test including one-axis vibration. This re-test plan was approved by TRW (see DSCS-BIA-520). No other corrective action deemed necessary.

RELIABILITY ANALYSIS REPORT NUMBER V20326 AC191 --- REPORT NO. 21 04-22-77

PROJECT	777R		TEST LEVEL	3	DATE INITIATED 04-03-77
SYSTEM S'N			TEST TYPE	ACCEPTANCE	DATE CLOSED - -
SUBSYSTEM NAME	COMM		ENVIRONMENT	VIBRATION	CRITICALITY MAJOR
ORIGINATOR'S NAME	HEILE	R	TEST PROCEDURE	B200300-410	FAILURE CAUSE WORKMANSHIP
MFG CCC			PARAGRAPH NO.	9.0	RESPONSIBILITY ESD SUPPLIER
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	6000.0	CORRECTIVE ACTION EMPLOYEE INSTRUCTED
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000	

ASSEMBLY NAME	TWTA LL	PART NO.	310541-001	SERIAL NO	14-28	MANUFACTURER	HUGHES
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER	
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER	
COMPONENT PARTS	RESISTOR,MF	PART NO.	RNC654023FS	SERIAL NO.	7415	MANUFACTURER	MEPCO

DESCRIPTION OF FAILURE.

UNIT EXHIBITED IMPROPER OUTPUTS ON ALL TELEMETRY CHANNELS IN POST-VIB TESTING.

FAILURE ANALYSIS.

FAILURE WAS TRACED TO A BROKEN LEAD ON R6 (SIT RESISTOR) IN THE NEGATIVE HIGH VOLTAGE FEEDBACK LOOP OF THE HV MODULE. EXAMINATION SHOWED THAT THE FAILURE WAS CAUSED BY THE RESISTOR LEAD HAVING BEEN BENT TOO CLOSE TO THE COMPONENT BODY (RATHER THAN AS PRESCRIBED BY THE LEAD BONDING PROCEDURE). IT WAS POSTULATED THAT THE LEAD BREAK OCCURRED DURING TUBE REWORK AND CONTINUITY WAS MAINTAINED AS A RESULT OF SPRING TENSION ON THE LEAD UNTIL THE VIBRATION EXPOSURE CAUSED THE OPEN CIRCUIT.

CORRECTIVE ACTION/COMMENTS.

EXAMINATION OF OTHER COMPONENT LEAD BENDS DID NOT DISPLAY A SIMILAR DEFICIENCY. A COPY OF THE TFR WAS GIVEN TO THE COGNIZANT ASSEMBLY SUPERVISOR TO APPRISE HIM OF THE CONSEQUENCES OF NOT FOLLOWING THE CORRECT LEAD BEND PROCEDURE. UNIT WAS RETESTED SUCCESSFULLY AFTER REWORK.

workmanship

RELIABILITY ANALYSIS REPORT NUMBER T21037 AC191 —- REPORT NO. 21 05-06-77

PROJECT	777R		TEST LEVEL	1	DATE INITIATED	04-27-77
SYSTEM S'N	3-9		TEST TYPE	BENCH	DATE CLOSED	- -
SUBSYSTEM NAME	COMM		ENVIRONMENT	AMBIENT	CRITICALITY	MAJOR
ORIGINATOR'S NAME	GARLOW	CH	TEST PROCEDURE	DR 065 02H	FAILURE CAUSE	UNDER INVESTIGATION
MFG CCC			PARAGRAPH NO.	3.9	RESPONSIBILITY	ESD SUPPLIER
RELIABILITY ENGINEER	HEILE	R	CUM OPERATING TIME	0000.0	CORRECTIVE ACTION	UNDER INVESTIGATION
RESPONSIBLE ENGINEER	HALBIRT	C	CUM CYCLES	000		

ASSEMBLY NAME	TWTA,HL	PART NO.	310542-002	SERIAL NO.	24-19	MANUFACTURER
SUBASSEMBLY NAME		PART NO.		SERIAL NO.		MANUFACTURER
DETAIL SUBASSY		PART NO.		SERIAL NO.		MANUFACTURER
COMPONENT PARTS		PART NO.		SERIAL NO.		MANUFACTURER

DESCRIPTION OF FAILURE.

SMALL SIGNAL GAIN IS INTERMITTENT WHILE ON FLT 9 S/C

FAILURE ANALYSIS.

UNIT RETURNED TO HUGHES. F/A IS PENDING.

CORRECTIVE ACTION/COMMENTS.

C/A IS PENDING.

APPENDIX C-5

IOC DSCS-D3-1768, FINAL REPORT
PARTS INVESTIGATION, PROGRAM 777R TWTA ANOMALY

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA 90278

INTEROFFICE CORRESPONDENCE

DSCS-D3-1768

TO: W. R. Brannian
J. A. Durschinger ✓

CC: Data Center
J. A. Nisenbaum
C. D. Halbert
J. Wrobleski
B. Spanier
P. Pavesi

DATE: 4 August 1977

SUBJECT: Final Report - Parts Investigation Program 777R TWTA Anomaly

FROM: C. B. Irwin

BLDG.	MAIL STA.	EXT.
M3	2465	61881

I. SUMMARY

This report concludes the Parts Investigation relating to the failure history of HAC/EDD Model 1202HA TWTA's initiated as the result of Program 777R Flight 8 TWTA failure. Parts were identified as critical to suspected TWTA failure modes. Review of test data, part history, ratings and applications shows that there is no identifiable part problem relating to the known primary failure modes.

The TWT R. F. Connector requires specific improvement as the result of decreased R. F. output experienced during Thermal Vacuum test on TWTA S/N's 14-24 and 14-25.

II. PARTS INVESTIGATED

Results of parts investigated as critical on HAC/EDD TWTA Schematic Drawing B200350-210, Rev. B are summarized in Table I.

In addition to Table I, a survey was made of known HAC/EDD part failures identified as the result of part level lot qualification tests. Although one part (i.e., JANTX1N751A) was common to the Table I investigation, the discrepancy was not identified to suspected TWTA circuit operation. (Reference Attachment VIII).

III. RECOMMENDATIONS

Rework TWTA S/N 14-24 and 14-25 TWT R. F. Connector to correct the R. F. output anomaly.

C. B. Irwin

CBI:ns

Attachments:

R. E. Doyle

SYSTEMS 0160 REV. 3-76

TABLE I

PART INVESTIGATION RESULTS

SCHEMATIC SYMBOL	PART TYPE	HAC/EDD PART NO.	CAUSE OF INVESTIGATION	RESULTS
CR12	Diode	JANTX1N4942 LDC 7433	Intermittent Short-TWTA 24-17 High Voltage Module (S/N 002). Diode replaced problem corrected. Diode lost and not analyzed. ~~(Ref.: Attachment I and II)~~	Analysis of Part construction and TRW history of similiarly constructed Diodes did not confirm a "short" failure mode. ~~(Ref.: Attachment III)~~
C3, C4, C5	Capacitor, .01 MFD, 6KV	B200379-012	Circuit analysis for possible short	No history of prior part failure detected. Suspected failure mode not verified.
C2, C7	Capacitor .01 MFD, 5KV	B200379-011	Circuit Analysis for possible short.	No history of prior part failure detected. Suspected failure mode not verified.
VR2	Diode, Zener	JANTXV1N751A LDC 7338	Circuit analysis of possible drift in reverse current could cause Helix over-current trip.	Manufacturer, Motorola, supplied data of similar lot which showed good stability of reverse current. They also stated that there were no problems with LDC 7338, i. e., results of Group A, B and screening tests were good and were normal. Motorola indicated that the reverse current leakage (I_R) measured at -2 to -3 volts would not exceed 5 micro amps during normal usage for the diode life. Suspected failure mode not verified. ~~(Ref.: Attachment IV).~~

TABLE I (CON'T.)

SCHEMATIC SYMBOL	PART TYPE	HAC/EDD PART NO.	CAUSE OF INVESTIGATION	RESULTS
T1, T3	Transformer	B201628-001	Circuit analysis of possible dielectric (primary to secondary) breakdown.	No part failure mode detected. ~~(Ref.: Attachment V, A/I 06-06-3)~~
R6	Resistor, 10K, 1/8 M		Same as for VR2 since part is in series.	No part problem detected.
T2	Transformer	B201627-001	Possible overstress in TWTA 24-17 H.V. module S/N 002 (Ref.: Attachment I and II)	No part failure mode detected. ~~(Ref.: Attachment II and V)~~.
J1, J2	TWT RF Connector		R. F. output power dropped during Thermal Vacuum test of TWTA S/N 14-24 and 14-25 (Ref.: Attachment VI).	Cause of failure 1. Pin/contact misalignment (Ref.: Attachment VII). 2. Large Braze Fillet on pin. (Ref.: Attachment VII) 3. Ground spring loose. (Ref.: R. Salcedo) 4. Possible oversize pin/ undersize contact resulting in point pin to contact mating (Ref.: R. Salcedo) TWTA S/N 14-24 and 14-25 connectors ~~are to be~~ reworked ~~(Ref.: Attachment VII)~~.

C-68

24-17 HIGH VOLTAGE MODULE.

ATTACHED HISTORY SHOWS THIS MODULE HAD INTERMITTENT SHORT.
FAULT WAS TRACED (BY LIFTING LEADS) TO AREA OF CR12, WHICH IS HALF OF A TELEMETRY OUTPUT RECTIFIER ON ONE WINDING OF HV XFMR T2. CR12 WAS REPLACED AND THE FAULT CLEARED. CR12 WAS NOT CHECKED OUTSIDE TO CONFIRM THE FAILURE.*
CR12 IS A UNITRODE JANTXV IN4942 LOC 7433. AN INTERMITTENT SHORT OF THIS PART IS HIGHLY UNLIKELY (HUGHES OPINION ALSO). IT IS REASONABLE TO BELIEVE THE SHORT IS IN THE BOARD OR WIRING, NOT THE DIODE, AND HAS RECURRED. IN ANY CASE THE FAULT PROBABLY DAMAGED T2 DURING GROUND TESTING, AND IT IS POSSIBLE T2 FAILED.
BREADBOARD SIMULATION OF CR12 SHORT EXACTLY DUPLICATES THE 24-17 FAILURE. SO FAR, HUGHES CANNOT FIND THE PART.

THE F8 FAILURE IS THUS REASONABLY EITHER A RECURRENCE OF THE ORIGINAL INTERMITTENT SHORT, OR A FAILURE OF T2 DUE TO OVERSTRESS DAMAGE.

12 June 77

* TECH. DEFINITELY REMEMBERS DIODE WAS NOT CHECKED.

(1)

B200361-140 H.V. Module S/N 002 Sequence.

2/9/76 Rework O.S. -1 to replace all Bridges (Defective Lot)
2/17/76 Completed Rework O.S. -1.
3/9/76 Initial Functional test, with H.V. module Tester, performed OK.

3/9/76 started Integration test of H.V. Mod. 002 & S.C. Mod 002

3/10/76 continued Int. Test & found Drift of E_b.

3/11/76-3/18/76 Unit in Evaluation (T.V., B.B., etc)

3/19/76 Rework O.S. -2 to Replace T-1 (collector X-former)

3/23/76 Rework O.S. -2: On repeat of Initial Functional Test was being performed; using H.V. module Tester, unit drew excessive current. (Voltage is started at zero and shall not exceed 2A at 10V. When unit exceeded 2A at less than 10V, it was shut off.)

Unit was set aside for Priority DX unit.

3/24/76 Unit was wire checked with no anomalies found.

Functional test performed normally and unit completed -2 Rework O.S.

3/25/76 Re-started Int. Test of H.V. 002 & S.C. Mod 002. Drift again found in E_b.

Substituted Collector-filter Caps external to unit & Drift stopped.

3/26/76 Rework O.S. -3 to replace C2 & C7.
3/29/76 Completed Rework O.S. -3.

4/2/76 NOTE: AT THIS POINT, MATED S.C. MODULE 002 & H.V. MODULE 005. DATA AVAILABLE IN OTHER PACKAGES, AND TESTING TOOK SEVERAL DAYS DUE TO PRIORITIES, BUT THE SAME DRIFT IN E_b WAS FOUND.

4/13/76 Started Ant. Test of H.V. module 002 & S.C. module 005.
"S.C. module appeared to fail when taking bus voltage reading."

Units then separated.

H.V. module placed in Vacuum chamber for test, no anomalies.—

4/14/76 Re-Test H.V. module as OK in Vacuum Chamber.

Re-assigned S.C. module S/N 002 and re-started Ant. Test. At time out, Drew excessive current & tripped. Separated modules.

H.V. module S/N 002 tested separately & exceeded 2A at much lower than 10V.

4/15/76 NOTE: H.V. MODULE 005 WHICH HAD DRIFT WITH S.C. MODULE 002 WAS TESTED OK WITH S.C. MODULE 004.

4/20/76 Rework O.S. —4 started troubleshooting H.V. module & found shorted CR12.

CR12 replaced.

Unit re-tested on module tester as OK.

5/4 & 5/5 Ran Ant. Test. & Regulation Curves on H.V. module 002 & S.C. module 006.

5/10/76 Ran Integrated Functional Test.

5/13/76 Unit Potted.

5/17/76 Excess Potting machined off. (O.S. 361L02-M)

(3)

Brackets

5/17/76 ITR 82761 issued for damaged nutplate threads in machining.

5/18/76 Rework O.S. -5 to repair nutplate.

5/20/76 Tested in module Tester OK.

5/20/76 Performed Corona Test OK.

5/21/76 Unit closed to Stores.

NOTE: (The Drift problem was subsequently traced to a "mismatch" in switching times of Q5 & Q6 in the S.C. modules. As a result, the Integration Sequence was changed to match the S.C. module to an assigned H.V. module prior to foaming.)

777 ANOMOLY INVESTIGATION
ACTION ITEM RESPONSE

A/I 06-13-1: During testing of the high voltage (H/V) module (S/N 002), it was observed that input current exceeding that allowed in the test procedure was drawn by the module. The procedure allows 2 amps at 10 vdc; the technician observed >2 amps below 10 vdc and terminated the test.

During integrated module test involving H/V module S/N 002 and a semiconductor (S/C) module, the test was terminated through action of the trip circuit in the S/C module, indicating the input current had exceeded that necessary to activate the trip circuit (approximately 8 amps).

The problem was altimately traced to a shorted 1N4942 diode, CR 12 on the H/V module Telemetry PWB. This diode halfwave rectifies the converter drive signal used to develop the cathode high voltage and is used for cathode voltage telemetry. Unfortunately, the diode itself was misplaced after removal from the Telemetry PWB and no record of reliability analysis can be found. The symtoms and test conditions are well documented; however, a question has been raised as to whether the cathode transformer T2 (B201627-001) had been overstressed due to abnormal currents flowing when CR 12 was shorted.

Measurements were taken on the 1202HA breadboard simulating a shorted CR 12. It was found that 5 amps peak-to-peak current flows in the half winding of the T2 secondary connected to CR 12 (T2-Pin 9). One half the primary of T2 (T2-Pin 1 to Pin 2) drew 12 amps peak-to-peak. These measurements were taken using the full EPC breadboard which is similar to the integrated module test setup. Discussions with H. Ashe of HAC/Culver City concerning overstress in T2 under the above conditions gave the following results:

1. The secondary of T2, Pins 7-8-9, could tolerate 5 amps RMS for 8 sec. before the windings would fusc.
2. The primary of T2, Pin 1-2-3, could tolerate 12 amps RMS for 238 sec. before the windings would fuse.
3. Since the primary and secondary windings of T2 were exposed to 12 amps and 5 amps peak-to-peak, respectively, there is almost a 3 to 1 safety margin in current. Also, the trip circuit activates in a maximum of 0.24 sec. Therefore, the conclusion is the windings would barely get warm let alone approach the point of fusing, under the condition of a shorted CR 12.

Under the condition of the H/V module test, the operator observed greater than 2 amps, but less than 3 amps, before the input voltage reached 10 vdc, and terminated the test. During normal test operation, the test set and the H/V module draw approximately 4 amps at 28 vdc. Therefore, during the condition of CR 12 being shorted while in the H/V module test configuration, T2 was not exposed to even current normally applied during test and operation.

The conclusion is that T2 was not overstressed during testing and was completely flight worthy when TWTA 14-15 was delivered to TRW.

ATTACHMENT III

TRW SYSTEMS GROUP

J. S. Gillette

INTEROFFICE CORRESPONDENCE

DSCS-D3B-222
5512.1-367/77

TO: R. Doyle R&D CC: R. Blessing DATE: 11 July 1977

SUBJECT: 777R Failure History Search of Unitrode JANTX1N4942 Rectifier

FROM: G. E. Staack
BLDG. R6 MAIL STA. 2184 EXT. 51574

REFERENCES: 1) CPER A-77-247
2) IOC 7512.1-602/76
3) IOC 7512.1-302
4) IOC 7512.1-344

INTRODUCTION: The subject part is used by subcontractor Hughes Aircraft in the high voltage power supply of a TWTA. Approximately one year ago, Hughes experienced a loss of high voltage during a TWTA acceptance test. A Unitrode JANTX1N4942 rectifier was replaced, and the high voltage returned. The replaced part was not analyzed, but it was assumed to have been shorted. The referenced CPER requests that a search be conducted of available files to see if failure history exists for the Unitrode rectifier that may indicate the reason for the failure.

CONCLUSION: The search did not produce evidence of Unitrode diodes shorting, but did reveal a history of reverse leakage problems on two lots received on TRW Purchase Orders in 1973 and 1976.

INVESTIGATION: A data search was conducted on the family of generic rectifiers 1N4942, 1N4944 and 1N4946 fabricated by Unitrode which included commercial, military and TRW specification 1D070 and 1D090. The search covered the following sources:

1. TRW History File for 1D070 and 1D090.
2. Component Analysis (CA) files.
3. DPA files.
4. GIDEP alerts.
5. Component Department Laboratory (CDL) Test Reports.
6. Failure Analysis Reports (FAR's).
7. Reliability Action Requirements (RAR's).
8. Design Alert Bulletins (DAB's).
9. Unitrode History file.
10. Unitrode telecon with their QA (6-27-77).
11. DESC telecon (6-29-77).

RESULTS: Problems found during the investigation are listed as follows:

1. P.O. Number D95911PA6: Quantity - 1195 parts for DSSO Program; Part Number 1D070-002V-210 (JANTXV1N4944).

   a) DPA Number 6AQU0375 completed 8-6-76. Two of five devices exhibited voids at the glass/terminal pins interface.

   The voids are the result of the glass collar not fusing to the terminal pins in areas were deposits of solder were not removed prior to their insertion to the glass collar and fusion of it to the silicon and to the terminal pins (PDR# 05736 dated 8-21-76).

   b) On 5-26-77 DCA rejected 218 devices (DC 7607). Of these 190 were electrical rejects due mainly to parts exceeding V_F, IR and ΔIR drift limits. Variables data was not available.

   50 - rejected at 1st electrical
   78 - rejected after HTRB electrical
   88 - rejected after delta computations

   PCWO 41543 requested tests be performed to upgrade parts to 1D090-002 (8-13-76).

   c) IOC 7512.1-602/76 dated 8-24-76 - Subject: DSSO Get Well Program for 1D070-002V-210 diodes reveals a total of 13 IR rejects were found of which nine, whose readings exceeded 10μA (maximum limit is 1.0μA), exhibited instability.
   The lot of 909 was accepted for systems use after IR tests, stability screening by scope, and visual inspection.

   d) PDR 07086 dated 8-25-76 indicates 940 parts were tested for IR resulting in 3 rejects. Largest IR readings was 1460nA. Thirty-four parts were rejected for internal visual anomalies (reasons for rejections were not available).

RESULTS: Continued

2. P.O. Number 042PX3; Quantity - 360 parts - JANTXV1N4942 for BOA-13/KR23 Retrofit Program.

   a) Eleven ΔIR failures and two (2) V_F failures after 130 hour burn-in. All units were still well within the 1μA leakage limit (reference IOC 7512.1-302 dated 22 June 1973). Further testing, as outlined in IOC 7512.1-344 resulted in the following tabulation of failures and anomalies:

Catastrophic failures	-	0
ΔIR failures stabilized within 1μA limit	-	12
ΔIR failures not stabilized but within 1μA limit	-	1
ΔIR failures and beyond 1μA IR limit	-	4
V_F failures	-	1

Based on accumulated data screened parts were accepted for systems.

G. E. Staack
Component Engineer

GES:ow

FROM: G. E. STAACK

DATE: 7/11/77

DOCUMENT NO:
5512.1-367/77
DSCS-D3B-222

DISTRIBUTION LIST

LIBRARY DISTRIBUTION: R6/1374

Part No: JANTX1N4942

Vendor: Unitrode

Project: 777R

Part No. (PAR Package File):

CDL No.

DEPARTMENT 5512 DISTRIBUTION:

X	IOC File		___	B. Evans	R6/2591
X	P. Pavesi	R6/2188	___	J. Gillette	R6/2184
X	W. Grimes	R6/2188	___	R. Perrin	R6/2188
X	S. Rice	S/1950	___	J. Willey	R6/2448

GENERAL DISTRIBUTION:

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PHYLLIS	M3/2465

MOTOROLA
Semiconductor Products Division
P.O. BOX 20906, PHOENIX, ARIZONA 85036

CUSTOMER DATA SUMMARY SHEET

TEST JANLN750A-JANLN751A 40CmW/ZZ319 GLA-72	SAMPLE PLAN SIZE	AQL / LTPD	LEVEL	ACCEPTANCE DATA REJECTS FOUND	TYPE	ACCEP. NO.	REJECT NO.	REMARKS
LOT SIZE: 21,317 DATE CODE: 7351 MIL-S-19500/127S RELEASED: 3/9/74								
Group A JANLN750A								
Subgroup I Vis. & Mech.	77	5		0		1	2	
Subgroup II Electrical Insp.	195	2		0		1	2	Go No Go
Subgroup III Electrical Insp.	195	2		0		1	2	Go No Go
JANLN751A								
Subgroup I Vis. & Mech.	77	5		0		1	2	
Subgroup II Electrical Insp.	195	2		0		1	2	Go No Go
Subgroup III Electrical Insp.	195	2		0		1	2	Go No Go
Group B								
Subgroup I Physical Dimensions	38	10		0		1	2	Go No Go
Subgroup II Solderability Thermal Shock (Temp. Cycling) Thermal Shock (Glass Strain) Thermal Strength Tension (Lead) Moist. Resistance End Points	38	10		0		1	2	Go No Go
Subgroup III Shock Vib., Var. Freq. Const. Acceleration End Points	38	10		0		1	2	Go No Go

SPD 1033 R-1 (9/68)

MOTOROLA
Semiconductor Products Division
P.O. BOX 20906, PHOENIX, ARIZONA 85036

CUSTOMER DATA SUMMARY SHEET

TEST JAN1N750A-JAN1N751A 400mW/CL319 GLA-72	SAMPLE PLAN			ACCEPTANCE DATA				REMARKS
	SIZE	AQL / LTPD	LEVEL	REJECTS FOUND	TYPE	ACCEP. NO.	REJECT NO.	
Page 2								
Subgroup IV Terminal Strength (Lead Fatigue)	38	10		1 0	J1N750A	1	2	No Elect. End Points
Hermetic Seal Fine Leak Gross Leak				0 1				
Subgroup V Surge Current End Points	38	10		0		1	2	Go No Go
Subgroup VI High Temp. Life (non-oper) TA=175°C, t=340 Hrs. End Points	105+ 5 spares	5		0		2	3	Recorded
Subgroup VII Steady State Oper.Life TA=25°C, t=340 Hrs. End Points	75+ 1 spare	7		2 1 1	IR1 VZ2 J1N751A	2	3	Recorded

SPD 2033 R-1 (9/68)

QACS0505 MEASUREMENTS COVER SHEET PAGE 1

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 10
PRIOR = NONE
TST CMPL = 00/00/00

SAMPLE SIZE = 110
REJECTS = 0
% REJECTED = .00 %

DESCRIPTION = JAN1N751A TZ319 400MW
B-6 HIGH TEMP LIFE
TA_175 DEG C
340 HR END POINTS TABLE 3

PARAMETER CONDITIONS	PARM #	TEST #	LIMITS		# FAILURES	REJECT CRITERIA
VZ 2	001	001				
			MIN =	4.85 V	0	ELECT READING
			MAX =	5.35 V	0	
IR 1	002	002				
			MIN =		0	ELECT READING
			MAX =	10. UA	0	
ZZT	003	003	PARM # 1 = 003			ARGUMENT = 0002. M CALC
			MIN =		0	ELECT READING
			MAX =	14. 0	0	

C-81

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 10

UNIT	VZ 2		IR 1		ZZT	
000001	5.2203	V	83.038	NA	2.747200	O
000002	5.1861	V	47.247	NA	1.3876500	O
000003	4.9530	V	657.16	NA	9.396500	O
000004	5.1166	V	38.153	NA	1.1175500	O
000005	4.9084	V	690.92	NA	7.992500	O
000006	5.0555	V	113.10	NA	2.981550	O
000007	5.2142	V	34.009	NA	1.2097000	O
000008	5.2594	V	22.522	NA	1.1010500	O
000009	5.1666	V	20.032	NA	917.9500	MO
000010	5.1111	V	26.636	NA	907.9000	MO
000011	5.1922	V	10.449	NA	1.790150	O
000012	5.1642	V	209.78	NA	1.2765500	O
000013	4.9945	V	146.42	NA	3.227250	O
000014	5.2728	V	12.451	NA	960.4000	MO
000015	5.2753	V	6.6620	NA	2.121900	O
000016	4.9316	V	529.60	NA	7.696500	O
000017	5.1715	V	41.925	NA	1.6116500	O
000018	5.0995	V	65.423	NA	1.993100	O
000019	5.1721	V	45.270	NA	1.731850	O
000020	5.2435	V	349.79	NA	1.1407500	O
000021	5.2386	V	37.494	NA	1.4511000	O
000022	5.2643	V	49.182	NA	877.4000	MO
000023	5.1800	V	223.75	NA	1.2970000	O
000024	5.0555	V	132.26	NA	2.243050	O
000025	5.1691	V	18.793	NA	901.5000	MO
000026	5.2692	V	78.485	NA	777.9000	MO
000027	5.1056	V	18.994	NA	1.4505000	O
000028	4.9975	V	160.58	NA	3.616650	O
000029	5.0903	V	895.14	NA	1.2823500	O
000030	5.2215	V	24.054	NA	1.0559000	O
000031	4.8968	V	389.83	NA	5.819500	O
000032	5.0836	V	28.473	NA	974.7500	MO
000033	4.9292	V	515.99	NA	7.547000	O
000034	5.1984	V	23.376	NA	960.1000	MO
000035	5.2576	V	15.375	NA	1.0885500	O
000036	5.2142	V	20.843	NA	1.1075000	O
000037	4.9164	V	533.14	NA	7.577500	O
000038	5.2136	V	31.232	NA	1.1026000	O
000039	4.8932	V	633.24	NA	8.169500	O
000040	5.0983	V	29.230	NA	1.2188500	O
000041	5.1678	V	41.571	NA	1.1514500	O
000042	5.2093	V	14.972	NA	853.2500	MO
000043	5.1056	V	95.898	NA	2.406300	O
000044	5.2179	V	21.789	NA	1.0894500	O
000045	5.2118	V	308.29	NA	968.0000	MO
000046	4.9896	V	161.13	NA	3.197950	O
000047	5.1312	V	95.764	NA	2.543950	O
000048	4.9615	V	203.06	NA	3.986500	O
000049	5.1764	V	402.28	NA	2.033400	O
000050	5.1800	V	13.080	NA	1.5072500	O
000051	5.1337	V	106.38	NA	1.4416500	O

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 10

UNIT	VZ 2		IR 1		ZZT	
000052	5.1837	V	8.3001	NA	1.973850	O
000053	5.2661	V	598.08	NA	986.6500	MO
000054	5.0445	V	93.060	NA	2.229300	O
000055	5.1330	V	43.036	NA	1.3223000	O
000056	5.2167	V	127.50	NA	1.0196000	O
000057	5.2423	V	7.4328	NA	1.866750	O
000058	5.2624	V	1.1267	NA	1.0061500	O
000059	5.2496	V	3.1641	NA	1.2726000	O
000060	5.2435	V	10.974	NA	1.0733000	O
000061	5.1703	V	24.481	NA	1.0544000	O
000062	5.2521	V	438.66	NA	1.2222500	O
000063	5.0824	V	221.37	NA	2.129800	O
000064	5.0342	V	103.82	NA	2.528050	O
000065	5.0922	V	61.426	NA	1.6388000	O
000066	5.1538	V	37.988	NA	1.2301500	O
000067	5.2710	V	5.9167	NA	921.9500	MO
000068	5.0049	V	154.85	NA	3.437200	O
000069	5.0482	V	119.63	NA	3.278800	O
000070	5.1703	V	996.46	NA	1.1960000	O
000071	5.2124	V	24.188	NA	1.0138000	O
000072	5.2301	V	11.737	NA	1.1386000	O
000073	5.2228	V	23.566	NA	1.0125500	O
000074	5.1691	V	146.67	NA	1.4422500	O
000075	5.0506	V	106.14	NA	2.940650	O
000076	5.0128	V	126.16	NA	2.905250	O
000077	5.0464	V	92.413	NA	2.488700	O
000078	5.2075	V	17.279	NA	1.0052500	O
000079	5.1935	V	28.168	NA	1.0235500	O
000080	5.1446	V	57.599	NA	2.141400	O
000081	4.9249	V	504.82	NA	7.370000	O
000082	5.0555	V	97.699	NA	2.640700	O
000083	5.1178	V	62.915	NA	1.764850	O
000084	5.0397	V	119.81	NA	3.183300	O
000085	5.1678	V	31.293	NA	1.1462500	O
000086	5.0494	V	93.750	NA	2.367850	O
000087	5.1617	V	162.35	NA	1.2433000	O
000088	5.1581	V	46.161	NA	1.726350	O
000089	5.1373	V	40.326	NA	1.2420500	O
000090	5.0506	V	101.50	NA	2.713300	O
000091	5.2203	V	152.77	NA	1.1276000	O
000092	5.2618	V	282.90	NA	915.8500	MO
000093	5.2032	V	244.81	NA	2.279950	O
000094	4.8883	V	435.91	NA	5.923500	O
000095	4.8834	V	718.75	NA	8.120500	O
000096	5.1691	V	29.767	NA	1.0898000	O
000097	5.0970	V	56.488	NA	1.801750	O
000098	5.2008	V	29.779	NA	1.2283500	O
000099	5.2167	V	22.162	NA	899.0500	MO
000100	4.8816	V	493.83	NA	6.332500	O
000101	5.2057	V	29.181	NA	1.1929500	O
000102	5.2545	V	9.796	NA	830.7000	MO

QACS0505 MEASUREMENTS READOUT DETAIL PAGE

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 10

UNIT	VZ 2		IR 1		ZZT	
000103	5.1532	V	23.053	NA	810.2500	MO
000104	5.2423	V	26.251	NA	1.1923000	O
000105	5.2508	V	365.84	NA	1.0165500	O
000106	5.2161	V	29.303	NA	1.4035000	O
000107	4.9621	V	193.24	NA	3.833900	O
000108	5.1446	V	34.698	NA	1.1133000	O
000109	5.1752	V	20.526	NA	5.984500	O
000110	5.1916	V	9.1815	NA	1.5231500	O

QACS0505 MEASUREMENTS COVER SHEET PAGE 1

DEVICE = JAN1N751A

CONTROL # = TS5157

LOT = 072

READOUT = 15

PRIOR = NONE

TST CMPL = 03/05/74

SAMPLE SIZE = 76

REJECTS = 2

% REJECTED = 2.63 %

DESCRIPTION = JAN1N751A TZ319 400MW
B-7 S.S. OPERATING LIFE
IZ_COL 8 TA_25 DEG C
340 HR END POINTS TABLE 3

PARAMETER CONDITIONS	PARM #	TEST #	LIMITS	# FAILURES	REJECT CRITERIA
VZ 2	001	001			
			MIN = 4.85 V	1	ELECT READING
			MAX = 5.35 V	0	
IR 1	002	002			
			MIN =	0	ELECT READING
			MAX = 10. UA	2	
ZZT	003	003	PARM # 1 = 003		ARGUMENT = 0002. M
			MIN =	0	ELECT READING
			MAX = 14. 0	1	

C-85

DEVICE = JAN1N751A
CONTROL # = TS5157
LOT = 072
READOUT = 15

UNIT	VZ 2		IR 1		ZZT	
000111	5.085	V	33.	NA	1.10000	0
000112	5.164	V	16.	NA	1.35000	0
000113	5.116	V	55.	NA	1.45000	0
000114	5.094	V	60.	NA	1.5000	0
000115	5.124	V	26.	NA	900.00	MO
000116	5.144	V	73.	NA	2.35000	0
000117	5.251	V	14.	NA	1.55000	0
000118	5.173	V	51.	NA	1.25000	0
000119	5.239	V	17.	NA	1.05000	0
000120	4.909	V	630.	NA	7.40000	0
000121	5.100	V	77.	NA	2.05000	0
000122	5.136	V	32.	NA	1.70000	0
000123	5.187	V	13.	NA	1.35000	0
000124	5.257	V	23.	NA	1.05000	0
000125	5.251	V	19.	NA	1.0000	0
000126	5.091	V	72.	NA	1.85000	0
000127	5.032	V	130.	NA	2.5000	0
000128	4.986	V	61.	NA	1.70000	0
000129	5.195	V	54.	NA	1.5000	0
000130	5.093	V	82.	NA	2.5000	0
000131	5.199	V	18.	NA	800.00	MO
000132	5.161	V	29.	NA	1.05000	0
000133	5.282	V	4.	NA	1.5000	0
000134	4.876	V	740.	NA	7.60000	0
000135	5.236	V	31.	NA	1.40000	0
000136	5.161	V	970.	NA	1.35000	0
000137	5.163	V	28.	NA	800.00	MO
000138	4.908	V	650.	NA	6.65000	0
000139	5.175	V	41.	NA	1.55000	0
000140	5.154	V	107.	NA	3.25000	0
000141	5.235	V	8.	NA	1.5000	0
000142	5.169	V	18.	NA	1.15000	0
000143	5.242	V	7.	NA	1.25000	0
000144	5.131	V	620.	NA	2.35000	0
000145R	5.149	V	15.	UA*	1.55000	0
000146	4.894	V	410.	NA	5.65000	0
000147	5.151	V	39.	NA	1.25000	0
000148	5.025	V	72.	NA	1.60000	0
000149	5.242	V	31.	NA	1.15000	0
000150R	4.209	V*	150.	UA*	25.65000	0*
000151	5.212	V	11.	NA	850.00	MO
000152	5.113	V	1.07	UA	2.70000	0
000153	5.200	V	8.	NA	1.20000	0
000154	5.228	V	41.	NA	1.35000	0
000155	5.235	V	50.	NA	1.0000	0
000156	5.186	V	41.	NA	1.30000	0
000157	5.031	V	6.5	UA	2.90000	0
000158	5.232	V	26.	NA	1.20000	0
000159	5.196	V	34.	NA	900.00	MO
000160	4.875	V	450.	NA	5.60000	0

QACS0505 MEASUREMENTS READOUT DETAIL PAGE

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 15

UNIT	VZ 2		IR 1		ZZT	
000161	5.175	V	72.	NA	1.15000	O
000162	5.251	V	19.	NA	900.00	MO
000163	5.162	V	35.	NA	1.25000	O
000164	5.078	V	111.	NA	1.90000	O
000165	5.139	V	57.	NA	1.95000	O
000166	5.098	V	18.	NA	850.00	MO
000167	5.120	V	59.	NA	1.55000	O
000168	5.207	V	48.	NA	1.60000	O
000169	5.171	V	30.	NA	800.00	MO
000170	5.061	V	54.	NA	1.45000	O
000171	4.985	V	430.	NA	3.65000	O
000172	5.133	V	610.	NA	2.45000	O
000173	5.051	V	160.	NA	2.45000	O
000174	4.861	V	950.	NA	89.0000	UO
000175	5.237	V	11.	NA	850.00	MO
000176	4.999	V	103.	NA	1.70000	O
000177	5.163	V	41.	NA	1.05000	O
000178	5.129	V	26.	NA	850.00	MO
000179	5.185	V	520.	NA	2.05000	O
000180	5.207	V	32.	NA	1.30000	O
000181	4.876	V	790.	NA	7.75000	O
000182	5.112	V	30.	NA	850.00	MO
000183	5.155	V	51.	NA	1.85000	O
000184	5.217	V	15.	NA	1.25000	O
000185	5.244	V	24.	NA	1.25000	O
000186	4.888	V	420.	NA	5.75000	O

QACS0505 MEASUREMENTS READOUT DETAIL PAGE

DEVICE = JAN1N751A

CONTROL # = TS5157
LOT = 072
READOUT = 15

REJECT LIST

000145 000150

777 ANOMALY INVESTIGATION
ACTION ITEM RESPONSE

A/I 06-06-3 A separate T-V test of individual 1202HA magnetic components is not necessary for the following reasons:

1. The high voltage magnetics were designed to operate in an encapsulated module (i.e. the high voltage module). Therefore, the individual magnetics would need to be encapsulated for an accurate simulation, and heating characteristics, as well as correct insulation spacings would be difficult to simulate within the potted block. Since four TWTA's are being tested in T-V for an extended time, this is a much better test.
2. The majority of analyzed failures involving high voltage magnetics has been due to cleavage cracks or separation of exterior potting from the magnetic component and not internal failures of the component itself.
3. A detailed review of the design and manufacturing processes of the 1202HA magnetics was made by TRW and Aerospace personnel, and sufficient confidence was gained to relegate a magnetic component failure to a low probability failure mode.

A/I 06-09-1 As a part of the original 777 1202H EPC design, a thermal analysis was performed in 1970 and reported in the EDD document provided TRW. In Table 4 of the report a unit temperature summary is shown which indicates an expected rise in temperature from the TWTA chassis to the TWT collector of approximately 30°F. This temperature gradient is considered valid for the current 1202HA configuration.

Using the TWTA chassis worst case temperature profile furnished by TRW, the temperature in the area of the collector is shown to be 167°F. This puts the collector and associated potting material at just under 200°F. Short term testing at EDD, which exposed the collector potting and conformal coat compounds to high temperature, has shown that no damage or degradation takes place below 250°F. Therefore, it is certain that normal operating conditions are well below (> 70°F) the upper limits of the TWT collector potting materials.

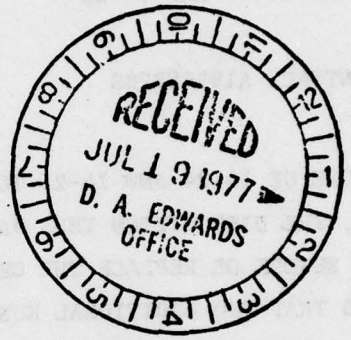
A/I 06-03-1 EDD can express no concern regarding the effect the number of on-off cycles during the special TWTA T-V test may have on reducing the longevity of the units undergoing the test. This position is based on knowledge of the temperature characteristics of each component and material, including the stress limitations, arrived at by either testing or manufacturer's recommendations. Although no short term on-off cycling combined with temperature cycling test data exists on TWTA's which are similar in number to those specified in the TWTA Special Test Plan, there is some operational data which supports the contention that approximately 120 on-off cycles over the ATP temperature range will not degrade the performance or life of the units.

1190H TWTA Program: >20,000 on-off cycles
777 Life Test Program: >200 on-off cycles per unit
TAXSAT Program: >240 on-off cycles per unit in space

A/I 06-10-1 A test was performed on the 1202HA breadboard at EDD. Helix current and the trip voltage (voltage at junction of C2 and VR2 of the trip circuit) were monitored during removal of the "ON" command following normal, stable operation of the EPC/TWT. At turn-off, no increase in helix current sufficient to initiate trip was observed, and the voltage at C2/VR2 was seen to decay immediately with no transient increase. The turn-off was repeated several times with the same results. It can be stated with certainty that removal of the ON command does not initiate the trip circuit due to a helix overcurrent transient.

ATTACHMENT VI

1977 JUL 18 PM 3:14



TRW DSSG RNDO

HUGHES TORR
18 JUL 77 310PM PDT

TRW
REDONDO BEACH CA
ATTN: DON EDWARDS M3/2153

SUBJ: HL TWTA'S 14-24 & 14-25

REF: (1) SUBCONTRACT A19148RPBS
(2) TRW TWX, DSCS-B1A-608, 7/7/77
(3) TRW TWX, DSCS-B1A-610, 7/11/77
(4) TRW TWX, DSCS-B1A-621, 7/14/77

REGARDING DISPOSITION AND REWORK OF 1202HA S/N 14-24 AND 14-25:

EVALUATION TESTING OF 14-24 HAS CONFIRMED THAT RF POWER OUTPUT WILL DROP AND IS DEPENDENT ON BOTH TEMPERATURE AND MECHANICAL PRESSURE ON THE TWT INPUT CONNECTOR. THIS IS INDICATIVE OF A DAMAGED OR INCORRECTLY SEATED CENTER PIN IN THE CONNECTOR. EDD RECOMMENDS THE FOLLOWING:

S/N 14-24

1. RETURN TWTA TO TWT DEPT. FOR STANDARD REWORK OF INPUT CONNECTOR. THIS CONSISTS OF REMOVING THE CONNECTOR, REPLACING THE CENTER PIN, AND REINSTALLING CONNECTOR. APPROPRIATE TRW AND AFPRO INSPECTION WILL BE INCLUDED.

2. RETURN UNIT TO TWTA TEST AREA AND VERIFY REWORK BY PERFORMING TEST ON THERMAL PLATE.

3. IF REWORK CORRECTS ANOMOLY, PERFORM BASELINE TEST PRIOR TO INSTALLATION OF IW TRIP OVERRIDE MOD.

4. PERFORM REWORK AND RETEST PER TRW TWX'S DATED 7/7/77 AND 7/11/77.

ATTACHMENT VII

HUGHES
HUGHES AIRCRAFT COMPANY

HUGHES–O–GRAM
OUTGOING WIRE COMMUNICATION

MESSAGE TO REACH DESTINATION (CHECK ONE)	☐ TODAY ☐ OVERNIGHT	LATEST TIME MESSAGE MAY REACH DESTINATION A.M.	P.M.

MESSAGE ORIGINATOR	TELEPHONE NO.	MAIL STA.	SOURCE CODE DIV	DEPT	SECT	AUTHORIZED BY
A. M. ORTA			96	29	10	DATE: 7/29/77

IMPORTANT: DO NOT USE MORE THAN 65 CHARACTERS OR SPACES PER LINE

PLEASE TRANSMIT THE FOLLOWING:

TO: TRW
REDONDO BEACH, CA.
ATTN: DON EDWARDS M3/2153

SUBJECT: REWORK, HL 14-24 AND 14-25

REFERENCE: SUBCONTRACT A19148RPBS
FILE:

RESERVED FOR COMMUNICATION CENTER

cc.
R Salcedo
D. Dodge
Return CI.

REGARDING REWORK OF 14-24 AND 14-25 TO RESOLVE THE PROBLEM OF SAG IN THE RF OUTPUT, THE DISPOSITION THUS FAR IS TO REMOVE THE TWT INPUT CONNECTOR AND REWORK OR REPLACE THE CENTER PIN. DURING THIS OPERATION IT WAS NOTICED THAT TWO ADDITIONAL NON-CONFORMANCES EXISTED IN TWT 515 (14-25) AND A SINGLE NON-CONFORMANCE IN TWT 504 (14-24).

TWT 515 EXHIBITED AN ECCENTRICITY OF THE INPUT MATCH PIPE WITHIN THE CONNECTOR SUPPORT STRUCTURE. THIS CAUSES A MISALIGNMENT BETWEEN THE MATCHPIPE CENTER PIN AND THE CONNECTOR CENTER RECEPTACLE. THE PROPOSED REWORK IS TO ELONGATE THE MOUNTING HOLES IN THE CONNECTOR SO AS TO ELIMINATE THE MISALIGNMENT.

THE SECOND CONDITION INVOLVES AN ABNORMALLY LARGE BRAZE FILLET AT THE BASE OF THE MATCH PIPE CENTER PIN WHICH INTERFERES WITH THE CONNECTOR CENTER RECEPTACLE AND CAUSES SPLAYING OF THE RECEPTACLE. THE PROPOSED REWORK IS TO SHIM THE CONNECTOR SO AS TO RAISE THE CONNECTOR RECEPTACLE ABOVE THE FILLET [redacted].

TWT 504 EXHIBITED THE SAME ECCENTRICITY OF THE INPUT MATCHPIPE AS DID TWT 515, AND THE REWORK DISPOSITION WILL BE THE SAME.

TRW CONCURRENCE WITH THIS REWORK IS REQUESTED. A COMPLETE FAILURE ANALYSIS REPORT WILL BE SUBMITTED.

356A CS NOV 69 (LONG FORM)

ATTACHMENT VIII

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA 90278

INTEROFFICE CORRESPONDENCE

DSCS-D3-1692

TO: C. B. Irwin

CC: See below

DATE: 26 May 1977

SUBJECT: Review of Available Part History Anomalies for HAC/EDD TWTA F7-F12

FROM: M. S. Glazer

BLDG.	MAIL STA.	EXT.
M3	2455	63390

In answer to your request for a review of part qualification test failures, and related anomalies the attached summary is presented herewith. This information was summarized from HAC/EDD correspondence during the F7 - F12 build.

M. S. Glazer

MSG:pla
Attachment
cc: A. Adams
R. Doyle
J. Durschinger
C. Halbirt
D. Fleming
P. Fowler
J. Nisenbaum
R. Perrin
T. Reiten
J. Wrobleski
Data Center M3/2923

RECEIVED
MAY 26 1977
C. B. IRWIN

SYSTEMS 0180 REV. 9-76

HAC/EDD TWTA PART SUMMARY

PART TYPE	PART NO.	TYPE OF FAILURE	CAUSE	RESOLUTION
Capacitor (wet slug) Tantalum	B202114-004 -002 -003 (908557-340) (Sprague)	During Qual Test noted 1.1 Microamp leakage after temp. cycle. spec. is 1.0 microamp max.	Unknown; all parts passed leakage current after 2000 life test	Vibration test on all flight parts do not use in 19V supply
Diode	JANTX1N751A (Motorola)	Part mis-labeled as JANTXV; also 8 parts rejected in x-ray; 1 ext. particle, 7 poor chip mounting	Failed PDA limit (20%)	Use as is after inspection without paint and comp. Qual., etc.
Operational Amplifier	908911-1 (Harris)	No failure - Parts located at El Segundo - Needed for production	Previous lot failed and scraped	Full lot qual on 11 pcs.
Diode Bridge	B200385 (JANTX1n4946) LDC 7543 (Unitrode)	Failed x-ray PDA limit	Apparent voids in potting epoxy due to improper epoxy mixture	Use as is after successful completion of mini. qual test
Resistor	B850200-080 (Caddock) used in low level high voltage module	Large increases of output high voltage after low temp. Turn on test regulation problem	Resistor cracked due to temp excursion. See ECN A21483	Replace with a larger resistor S/N 009 and up in all high voltage modules
Diode Bride	B200385-001 LDC 7609 (Unitrode) JANTX1N4946	After HTRB two diode bridges had leakage current in excess of 2.0 micro amp; read 2.7 and 3.5 micro amp.	Unknown - Lot qual was completed	Use as is; HAC/EDD engineering judgement; no response to justification request

APPENDIX D

TEST PLANS, PROCEDURES AND REPORTS

APPENDIX D-1

1202 HATWTA SPECIAL TEST PLAN
DSCS-II REPLENISHMENT PROGRAM, 6 JUNE 1977

1202HA TWTA SPECIAL TEST PLAN

DSCS-II Replenishment Program

TRW Part No. C310542-X

June 6, 1977

PREPARED BY J. J. Haupt 6/6/77

J. J. Haupt, Head
Quality Test Engineering

APPROVED BY R. Harrington Jr. 6/9/77

R. Harrington, Jr.
Program Manager

D. O. Lawrence 6/6/77

D. O. Lawrence, Manager
Microwave Subsystems Department

REVISIONS			APPROVED			
DATE	LTR	DESCRIPTION	QA	ENGR	MFG	REL
6-16 77	A	Revised per Customer request.	6/7/77	6/13/77		

1.0 SCOPE

This document describes the facilities used and tests to be performed on four (4) DSCS IIR 1202HA High Level Traveling Wave Tube Amplifiers (TWTA's).

2.0 RESPONSIBILITY

The 777 Program Manager or his designee is responsible for the control and direction of the test program outlined herein.

2.1 Quality Test Engineering is responsible for surveillance and/or performance of the testing.

3.0 TEST CONDITIONS

Refer to Figures 1, 2, and 3 for test and facilities configuration.

a. Input Voltage 32 $\pm$ .5 Vdc

b. R. F. output power $\sim$ 1 watt

c. Frequency (single point) 7450 MHz

d. Temperature (Note 1) 60 to 146 $\pm$ 5°F

e. Vacuum $\leq$ 5 x 10^{-5} Torr

f. Test duration 4 weeks

Note 1: Temperature to be continually cycled from 60 to 146°F with approximately a two(2) hour dwell period at each temperature. The temperature profile as estimated will provide four (4) complete cycles per 24 hour period.

4.0 DATA RECORDING

During the test program, the following parameters will be continually recorded:

a. R. F. Power Output

b. Telemetry Voltages: Ik, Ek, Iw, Ef, Iin

c. Temperature

4.1 A log book will be maintained for each TWTA under test and as a minimum contain the following:

a. TWTA Serial Number

b. Daily telemetry readings during the normal work week

c. Daily temperature and pressure readings during a normal work week

d. TWTA hours of operation

e. Malfunctions of test or environmental equipment

4.0 DATA RECORDING (Cont.)

4.1 (Cont.)

f. Observations and/or events pertinent to the test program

g. Stamp or signature of individual performing the daily test

4.2 Each unit will be cycled off and back on again once per day of each normal work day. The procedure is as follows:

a. With temperature sensor in center of units reading 80 ± 10°F, switch temperature control to "local".

b. Shut all four units off and leave off for 15 minutes.

c. After 15 minutes, turn on first unit with following sequence:

(1) At turn "on" command; recorder speed at 5 mm/min.

(2) Shortly before (3-5 secs) prior to "H.V. ON", switch recorder to 125 mm/sec.

(3) "Immediately" after (2-3 secs) "H.V. ON" switch recorder to 125 mm/min.

(4) Run at 125 mm/min for 2 minutes.

(5) Reduce speed to 5 mm/min and leave on.

d. Repeat the sequence of Step c for each of the remaining units.

e. Annotate each recording with unit no., channel I.D., date, speed changes, and operators initials/stamp.

5.0 FAILURE/EVENT REPORTING

Failures or unexplained events to either the units under test or the test equipment shall be reported to the 777 Program Manager or his designee immediately.

6.0 SAFETY PROVISIONS

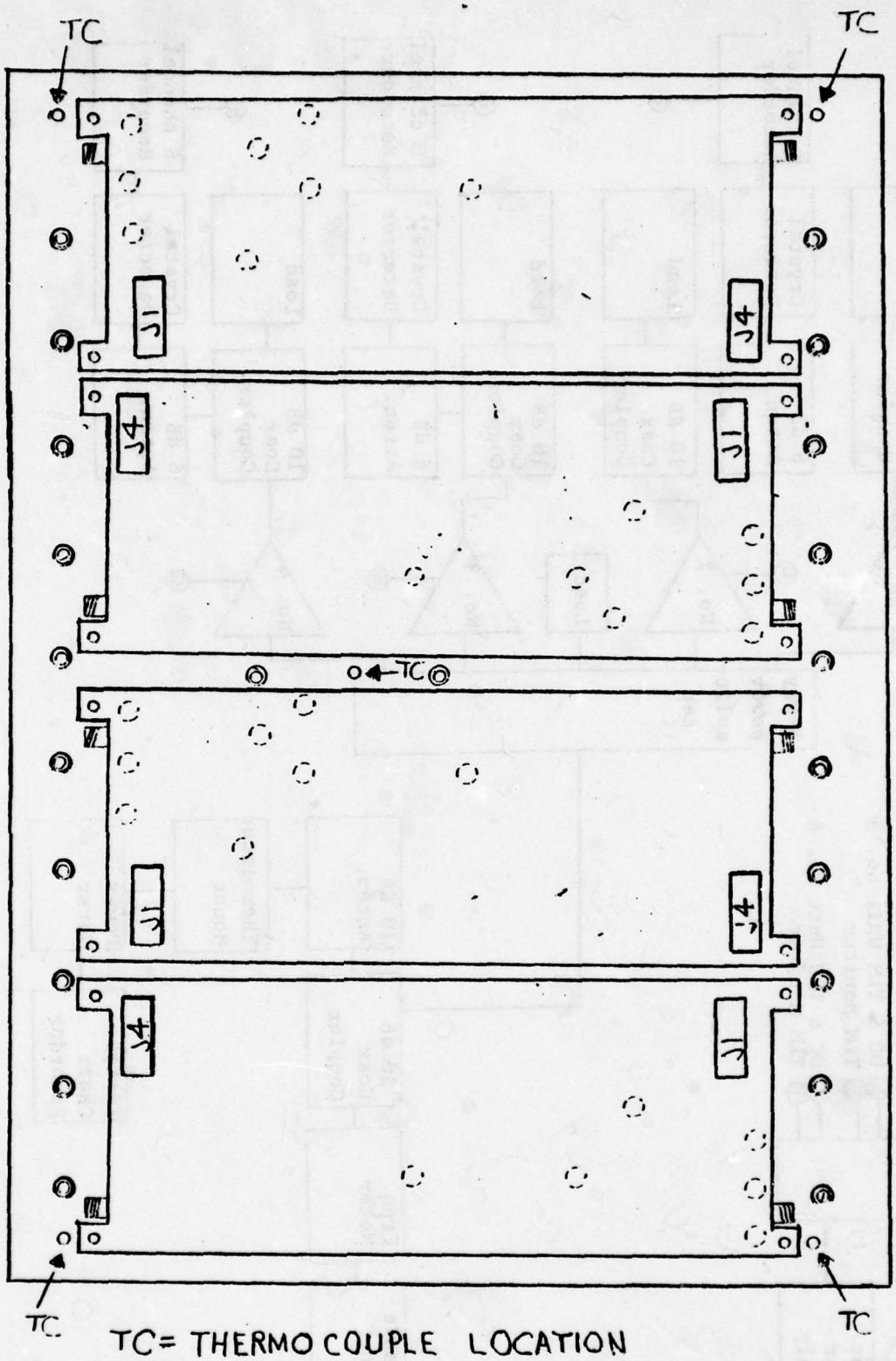
The DC input power supply is connected to a fail safe interlock which will remove DC input power from the units in the event of any one of the following conditions:

a. Temperature set point exceeded by 15°F

b. Loss of plant prime power in excess of one (1) second

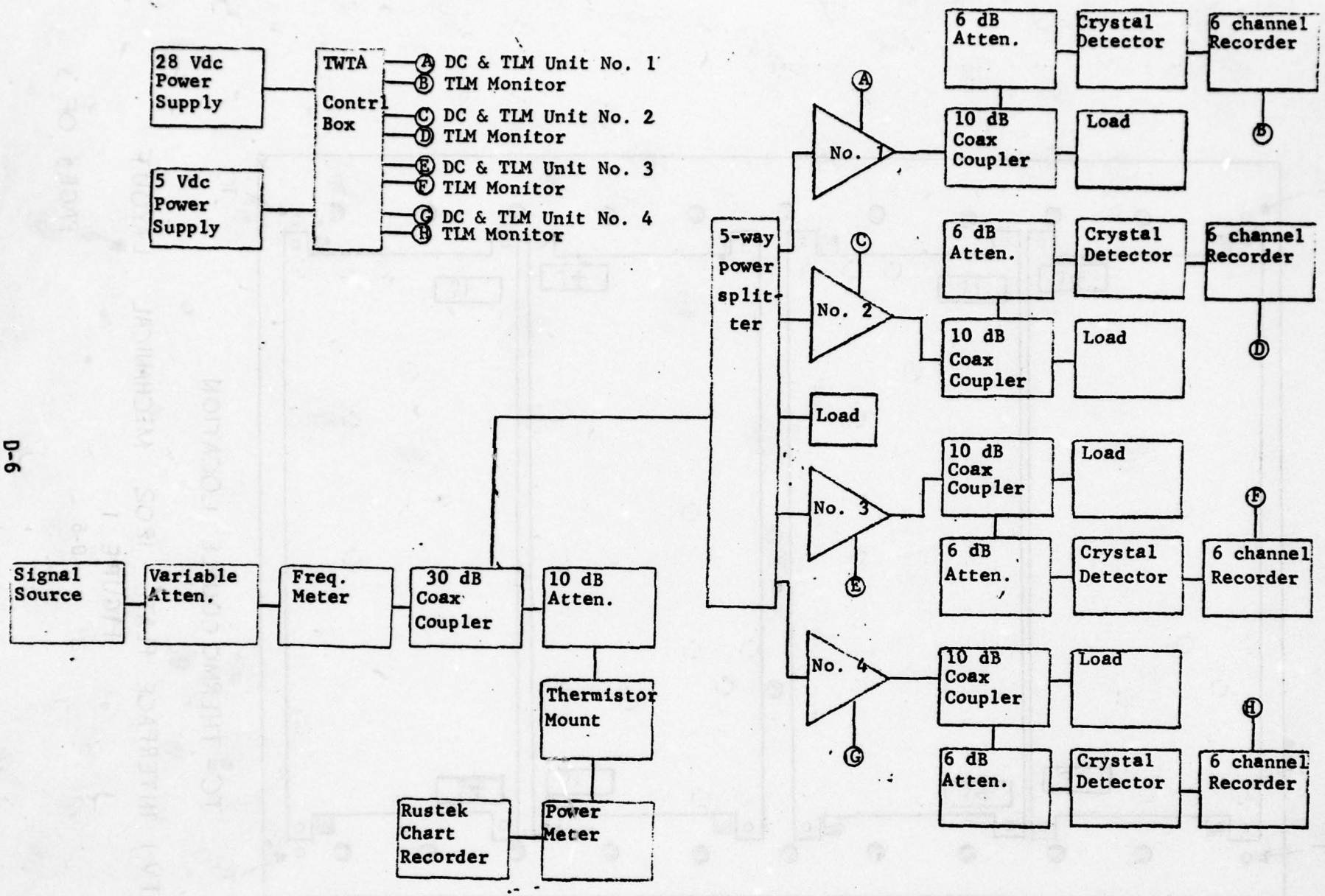
c. Loss of vacuum to $\leq 10^{-3}$ Torr

Each of the above conditions will also remove power from the heat exchanger; all conditions require a manual reset to restore normal operating conditions.



TC= THERMO COUPLE LOCATION

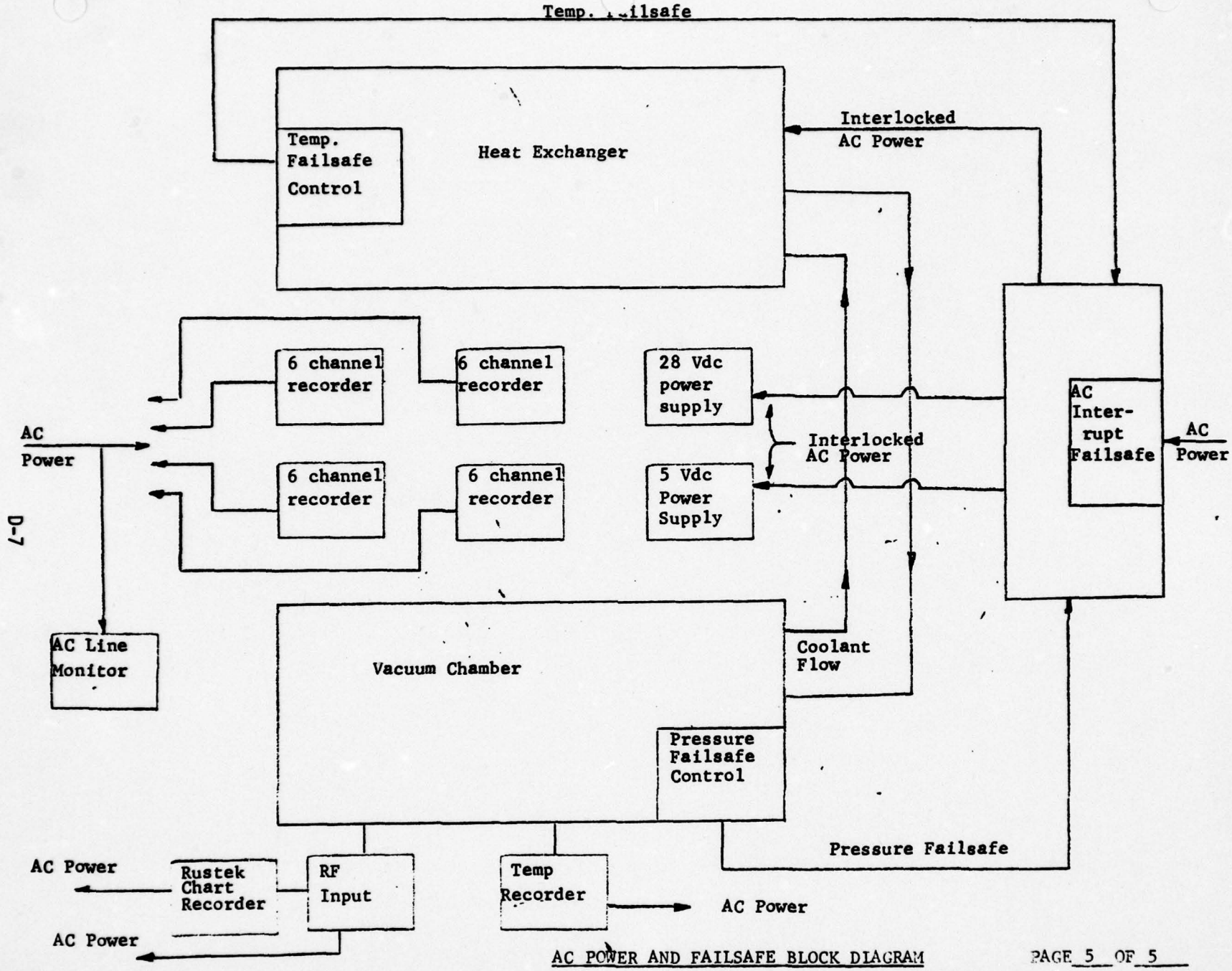
TV-I INTERFACE PLATE - 1202 MECHANICAL LAYOUT
FIGURE 1



D-6

RF and DC Block Diagram

Figure 2



D-7

AC POWER AND FAILSAFE BLOCK DIAGRAM

Figure 2

APPENDIX D-2

DSCS-II REPLENISHMENT PROGRAM HIGH LEVEL AND LOW LEVEL TWTA TEST PLAN, TP 777 REV. A, AUGUST 1975

HUGHES AIRCRAFT COMPANY
ELECTRON DYNAMICS DIVISION
3100 WEST LOMITA BOULEVARD
TORRANCE, CALIFORNIA 90509

W-06372

DSCS-II REPLENISHMENT PROGRAM

HIGH LEVEL AND LOW LEVEL TWTA

TEST PLAN

TP 777

REVISION A

August 1975

Prepared by _____
R. Harrington, Jr.

Approved by _____
J. H. Herman
Program Manager

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FOREWORD

This Test Plan is supplementary to the Program Plan (Paragraph I) as required by the Statement of Work, DSCS-BIA-008. The plan covers testing of all deliverable flight units.

1.0 LOW LEVEL TWTA (1200HA) TEST PLAN

1.1 SCOPE

The flight model 1200HA TWTA, HAC/EDD part number B200300-131/132, will be tested in accordance with EDD Acceptance Test Procedure, ATP B200300-400, Revision L, dated January 25, 1971, to insure compliance with TRW specification EC-EQ4-663D, Part I, dated December 1974.

1.1 TEST PLAN

1.1.1 The 1200HA TWTA will be tested to meet the acceptance test matrix from TRW specification EC-EQ4-663C, Part II, shown in Table 1. The testing method and procedure will be delineated by HAC/EDD test specification ATP B200300-400, Revision L, as further revised in accordance with the Statement of Work.

1.1.2 Prior to integration with a TWT, each electronic power conditioning (EPC) unit will be temperature cycled as follows:

(a) Ambient to +40°F for one hour.
(b) One hour transition to +130°F.
(c) +130°F for one hour.
(d) One hour transition to +40°F.

This cycle will be accomplished eight times. The unit will be operating at all times with output and telemetry voltages measured on the first and eighth cycles.

1.1.3 Prior to burn-in as described in Paragraph 1.1.4 below, each TWT will be exposed to a two cycle thermal shock test and a vibration test. This test is to manufacturing test levels as follows:

TABLE 1. ACCEPTANCE TEST MATRIX - LOW LEVEL TWTA

PERFORMANCE	REF. PARAGRAPH (EC-EQ4-663D)	3.1.1.1	3.1.1.3	3.1.1.4	3.1.1.5	3.1.1.6	3.1.1.8	3.1.1.10	3.1.1.11	3.1.1.12	3.2.1.1.2	3.1.1.1.3	3.1.1.9	3.1.1.7	3.2.1.1.3
TEST	REF. PARA.	POWER OUTPUT	GAIN	GAIN FLATNESS	GAIN SLOPE	GAIN STABILITY	NOISE FIGURE	TIME DELAY	INTERMODULATION DISTORTION	SPURIOUS OUTPUT	TWTA SUPPLY CHARACTERISTICS	STABILITY	PHASE CHANGE VERSUS INPUT POWER	VSWR	CATHODE ACTIVITY
FUNCTIONAL*		X	X	X	X		X	X	X	X	X	X	X	X	
VIBRATION	4.2.11	X	X								X				
FUNCATIONAL**			X	X	X						X				
THERMAL VACUUM	4.2.12	X	X	X	X	X			X	X	X				
FUNCTIONAL		X	X	X	X		X	X	X	X	X	X	X	X	X

*FUNCTIONAL TESTS MAY BE MADE IN ANY SEQUENCE.

**THIS MAY BE DONE WITH THE UNIT IN THE VACUUM CHAMBER PRIOR TO THE THERMAL VACUUM TEST.

Vibration	5g maximum, sine for approximately 2 minutes each axis.
Temperature Cycle:	$-50^{\circ}F$ to $+170^{\circ}F$ for 30 minutes at each limit. (See EDD DIP 19-31-19.)

Following 2,168 hours of burn-in but prior to integration with an EPC unit, each TWT will be exposed to a thermal vacuum test and a vibration test. This test is to acceptance test levels as follows:

Vibration:	9.8 grms, maximum random for 30 seconds each axis.
Thermal Vacuum:	$+40^{\circ}F$ to $+135^{\circ}F$ for 30 minutes at each limit. $\leq 1 \times 10^{-5}$ torr

1.1.4 Prior to acceptance testing, each TWT and EPC unit will be separately operated for 2,168 hours and 168 hours, respectively (burn-in), at $+125^{\circ}F \pm 15^{\circ}F$ and ambient pressure. Following integration of the TWT and EPC, followed by a limited functional test of the combined unit, each TWTA will be operated for 332 hours (burn-in) at $+125^{\circ}F \pm 15^{\circ}F$ and ambient pressure.

1.1.5 Acceptance testing of each TWTA begins with a functional test followed by a random vibration test composed of a one minute test in each of three orthogonal axes to a maximum level of .0625 g^2/H_3 and overall level of 9.8 grms. The spectrum shape is described in Table 2.

TABLE 2. RANDOM VIBRATION ACCEPTANCE LEVELS

MAXIMUM LEVEL	.0625 G^2/Hz
DURATION	60 SECONDS EACH AXIS
OVERALL	9.8 GRMS

GENERAL:

20 - 300 Hz INCREASING 3 dB/OCTAVE

300 - 1200 Hz FLAT (.0625 G^2/Hz)

1200 - 2000 Hz DECREASING 6 dB/OCTAVE

UNIT VIBRATION TO BE PERFORMED FOR 60 SECONDS IN EACH OF THREE MUTUALLY PERPENDICULAR AXES.

Vibration testing is followed by another functional test. Thermal-vacuum testing will then be performed on each TWTA. The chamber pressure will be less than or equal to 1×10^{-5} torr. The complete thermal-vacuum test cycle is illustrated in Figure 1.

The acceptance test is completed with a final functional test and visual inspection.

2.0 HIGH LEVEL TWTA (1202HA) TEST PLAN

2.1 SCOPE

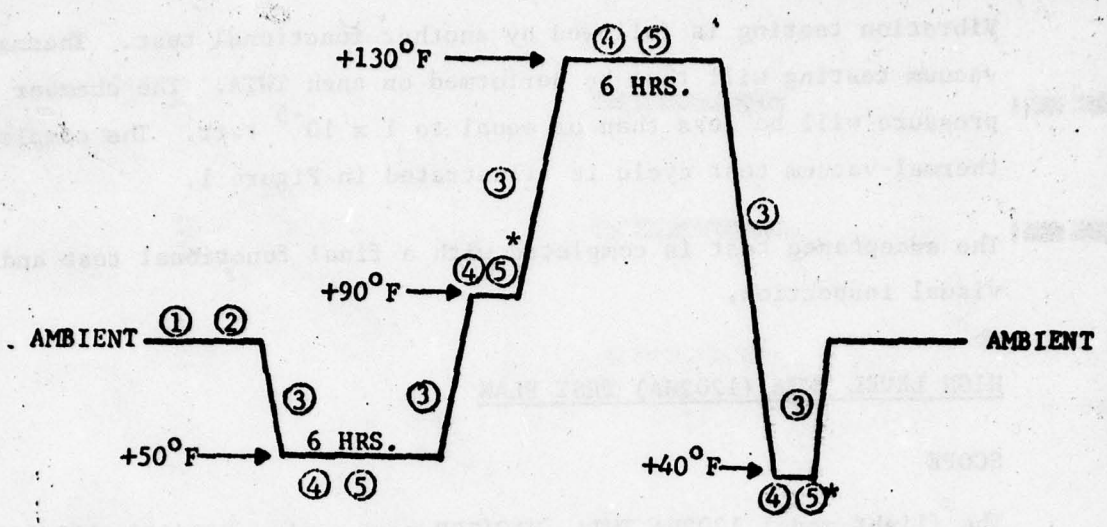
The flight model 1202HA TWTA, HAC/EDD part number B200350-.131/132, will be tested in accordance with EDD Acceptance Test Procedure ATP B200350-400, Revision L, dated March 18, 1971, to insure compliance with TRW Specification EC-EQ4-664D, Part 1, dated 30 December 1974.

2.2 TEST PLAN

2.2.1 The 1202HA TWTA will be tested to meet the acceptance test matrix from TRW specification EC-EQ4-664C, Part II, shown in Table 3. The testing method and procedure will be delineated by HAC/EDD test specification, ATP B200350-400, Revision L, as further revised in accordance with the Statement of Work.

2.2.2 Each TWT will receive 2,168 hours of burn-in prior to integration with the power conditioning unit. The test is to be conducted at $+125^{\circ}F \pm 15^{\circ}F$ and ambient pressure.

2.2.3 Prior to burn-in, each TWT will be exposed to a two cycle thermal shock test and a vibration test. The temperature and vibration limits are as described in Paragraph 1.1.3 above.



① BASELINE FUNCTIONAL TEST.

② CHAMBER PUMPDOWN TO 1×10^{-5} TORR.

③ TEMPERATURE TRANSITION (NOT TO EXCEED 10°F PER MINUTE).

④ TEMPERATURE STABILIZATION AT $\pm 5^{\circ}$F FOR 30 MINUTES.

⑤ FUNCTIONAL TEST AT STABILIZED TEMPERATURE AND PRESSURE.

*LIMITED TEST

FIGURE 1. THERMAL-VACUUM ACCEPTANCE TEST FOR LOW LEVEL TWTA

TABLE 3. ACCEPTANCE TEST MATRIX HIGH LEVEL TWTA

TEST	REF. PARA.	POWER OUTPUT	GAIN FLATNESS	GAIN SLOPE	SPURIOUS OUTPUT	SATURATED GAIN	SMALL SIGNAL GAIN	GAIN STABILITY	TIME DELAY	PHASE CHANGE VERSUS INPUT POWER	INTERMODULATION DISTORTION	TWTA SUPPLY CHARACTERISTICS	STABILITY	VSWR	CATHODE ACTIVITY
	REF. PARAGRAPH (EC-EQ4-664C)	3.1.1.1	3.1.1.3	3.1.1.5	3.1.1.6	3.1.1.7.1	3.1.1.7.3	3.1.1.7.3	3.1.1.9	3.1.1.12	3.1.1.13	3.2.1.1.2	3.1.1.10	3.1.1.8	3.2.1.1.3
	PERFORMANCE														
FUNCTIONAL*		X	X	X	X	X	X		X	X	X	X	X	X	
VIBRATION	4.2.10	X					X					X			
FUNCATIONAL**		X	X	X		X	X					X			
THERMAL VACUUM	4.2.11	X	X	X	X	X	X	X			X	X			
FUNCTIONAL***		X	X	X	X	X	X		X	X	X	X	X	X	X

*FUNCTIONAL TESTS MAY BE MADE IN ANY SEQUENCE.

**THIS MAY BE DONE WITH THE UNIT IN THE VACUUM CHAMBER PRIOR TO THE THERMAL VACUUM TEST.

***PARAGRAPH 4.2.12(a) DOES NOT APPLY.

Following 2,168 hours of burn-in but prior to integration with an EPC unit, each TWT will be exposed to a thermal vacuum and vibration test. The temperature, vacuum, and vibration limits are as described below:

Vibration:	9.8 grms, maximum random for 30 seconds each axis.
Thermal Vacuum:	$+60^{\circ}F$ to $+155^{\circ}F$ for 30 minutes at each limit. $\leq 1 \times 10^{-5}$ torr.

2.2.4 Each power conditioning unit will receive 168 hours burn-in prior to integration with the TWT. The burn-in will be performed at an elevated temperature of $+125^{\circ}F \pm 15^{\circ}F$ and $< 1 \times 10^{-5}$ torr pressurization.

2.2.5 Prior to integration with a TWT, each EPC unit will be temperature cycled as follows:

(a) Ambient to $+60^{\circ}F$ for one hour.
(b) One hour transition to $+146^{\circ}F$.
(c) $+146^{\circ}F$ for one hour.
(d) One hour transition to $+60^{\circ}F$.

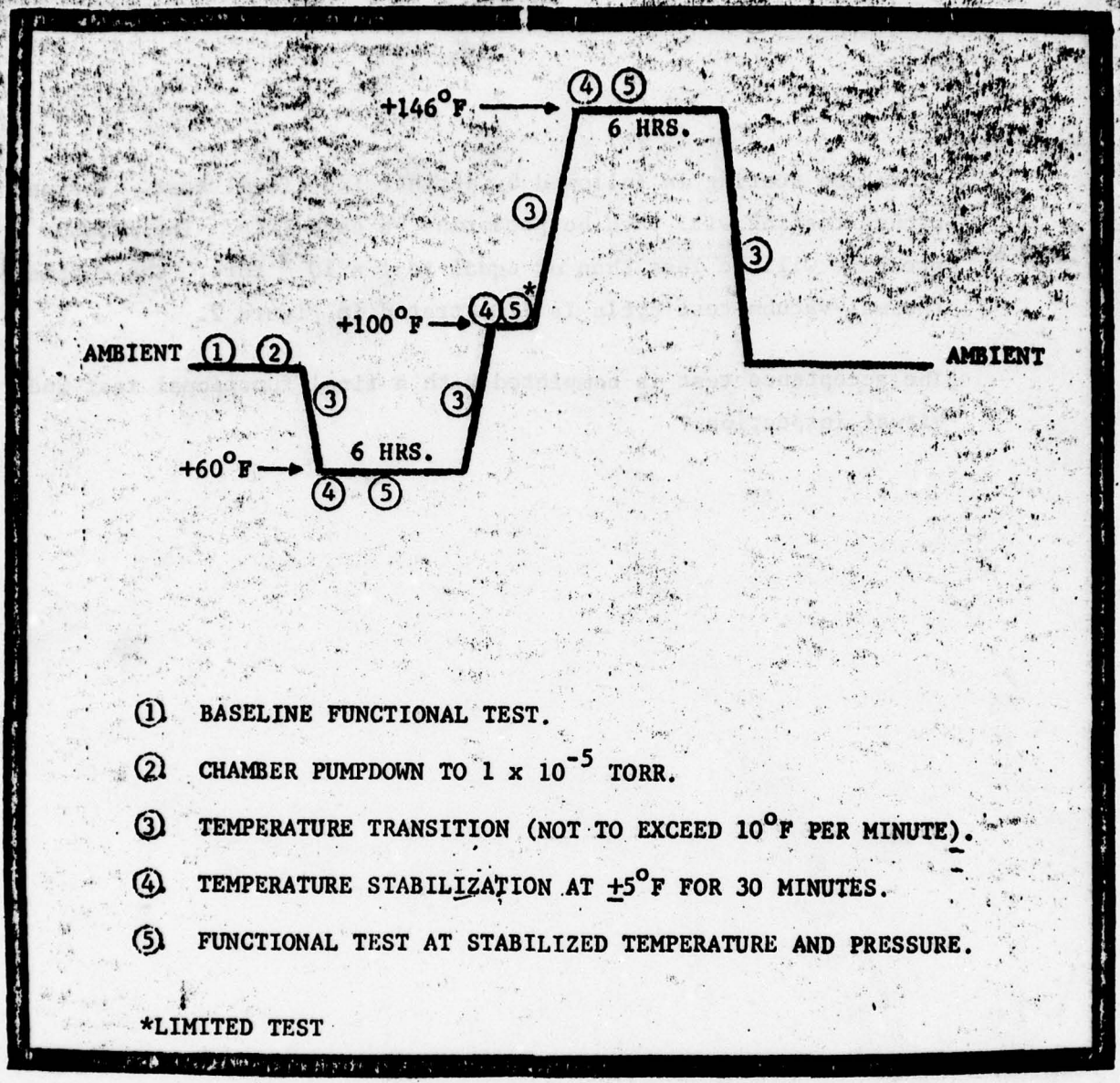
This cycle will be accomplished eight times. The unit will be operating at all times with output and telemetry voltages measured on the first and eighth cycles.

2.2.6 Each TWTA will be subjected to 332 hours of burn-in at an elevated temperature of $+125^{\circ}F \pm 15^{\circ}F$ and atmospheric pressure.

2.2.7 Acceptance testing of each TWTA begins with a functional test followed by a random vibration test composed of a one minute test in each of three orthogonal axes to a maximum level of .0625 g^2/Hz, an overall level of 9.8 grms. The spectrum shape is as shown in Table 2.

Vibration testing is followed by another functional test. Thermal vacuum testing will then be performed on each TWTA. The chamber pressure will be less than or equal to 1×10^{-5} torr. The complete thermal-vacuum test cycle is illustrated in Figure 2.

The acceptance test is completed with a final functional test and visual inspection.



(1) BASELINE FUNCTIONAL TEST.

(2) CHAMBER PUMPDOWN TO 1×10^{-5} TORR.

(3) TEMPERATURE TRANSITION (NOT TO EXCEED 10°F PER MINUTE).

(4) TEMPERATURE STABILIZATION AT ±5°F FOR 30 MINUTES.

(5) FUNCTIONAL TEST AT STABILIZED TEMPERATURE AND PRESSURE.

*LIMITED TEST

FIGURE 2. THERMAL VACUUM ACCEPTANCE TEST FOR HIGH LEVEL TWTA

APPENDIX D-3

IOC DSCS-G3-017, THERMAL EVALUATION
TEST OF HLTWTA-TO-DESPUN PLATFORM
INTERFACE, PROJECT 777, 10 AUG 1977, G.E. WESSEL

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA 90278

INTEROFFICE CORRESPONDENCE

DSCS-G3-017

TO: J. T. Bevans/H. M. Pan CC: Distribution DATE: 10 August 1977

SUBJECT: THERMAL EVALUATION TESTS OF HLTWTA-TO-DESPUN PLATFORM INTERFACE, PROJECT 777

FROM: G. E. Wessel
BLDG M2 MAIL STA. 1569 EXT. 62813

This IOC is for the purpose of transmitting the temperature-versus-time data recorded during eight individual thermal vacuum evaluation tests conducted on a test HLTWTA installed on the qual despun platform. The testing was performed in 5' X 6' T/V chambers in Buildings M1 and M4 from 21 July to 5 August 1977. For each of the thermal evaluation tests, the HLTWTA was mounted on the 121311-1 Qualification Despun Platform with the HLTWTA-to-platform interface being varied for each test. The various HLTWTA-to-platform interface configurations tested are described below. Refer to Figure 1 for details.

Configuration #1: RTV8111 between 'TWTA base area' and platform; a 1" X 1-1/2" 3 mil gold plated screen at M2, M3, and M4; one 122056-1 5 mil indium gasket over the 'aluminum plug'; 6-32 X 1-7/16 screws through the aluminum plug and into the TWT base at P1, P2, P3, and P4; 6-32 fasteners into top of platform at M1, M2, M3, and M4.

Configuration #2: Identical to configuration #1 except the 6-32 screw through the aluminum plug at location P2 was not installed.

Configuration #3: Identical to configuration #1 except the 122056-2 and -3 indium gaskets were installed. This configuration was per Dwg. 310511 H3.

Configuration #4: RTV8111 between 'TWTA base area' and platform; RTV8111 between 'aluminum plug' and tube base; 1" X 1-1/2" 3 mil gold plated screen at M1, M2, M3, and M4; 6-32 X 1-7/16 screws through the aluminum plug and into the TWT base at P1, P3, and P4; 6-32 fasteners into top of platform at M1, M2, M3, and M4.

Configuration #5: Identical to Configuration #2.

Configuration #6: Identical to Configuration #4 except, the thru screws into the tube at P1, P3, and P4 were not used.

Configuration #7: Identical to configuration #2 except the 122056-1 indium gasket at the aluminum plug was not used.

Configuration #8: RTV8111 between 'TWTA base area' and platform; two each 1" X 1-1/2" 3 mil gold plated screens at M2, M3, and M4; one 5 mil indium gasket over the entire surface of the aluminum plug; 6-32 X 1-7/16 screws through the aluminum plug and into the TWT base at P1, P2, and P4; 6-32 fasteners into top of platform at M1, M2, M3, and M4.

For each test, copper-constantin thermocouple temperature sensors were located as shown in Figures 2 and 3 as well as in Photographs 1 through 4. As indicated, the thermocouples designated TC1, TC2, TC10*, TC15, and TC16 were installed on the HLTWTA exterior, TC3 through TC9 were installed on the despun platform (TC3 and TC8 were installed on the aluminum heat sink), and finally TC11 through TC14 plus the collector thermocouple were installed on the interior of the HLTWTA. The temperature readout from each sensor was recorded on digital readout equipment during each test. During each test which was conducted with a vacuum of 2X10-5 torr or less, the high level tube was powered 'on' with the tube R.F. input and R.F. output being equipped with one watt and five watt loads respectively.

Tables 1 through 8 lists the time versus temperature data from each test. Figures 4 through 12 gives a graphical representation of selected thermocouple output.

G. E. Wessel
Mechanical Test Conductor
Project 777

D. J. Hiner
Test Manager
Satellite Test Operations
Project 777

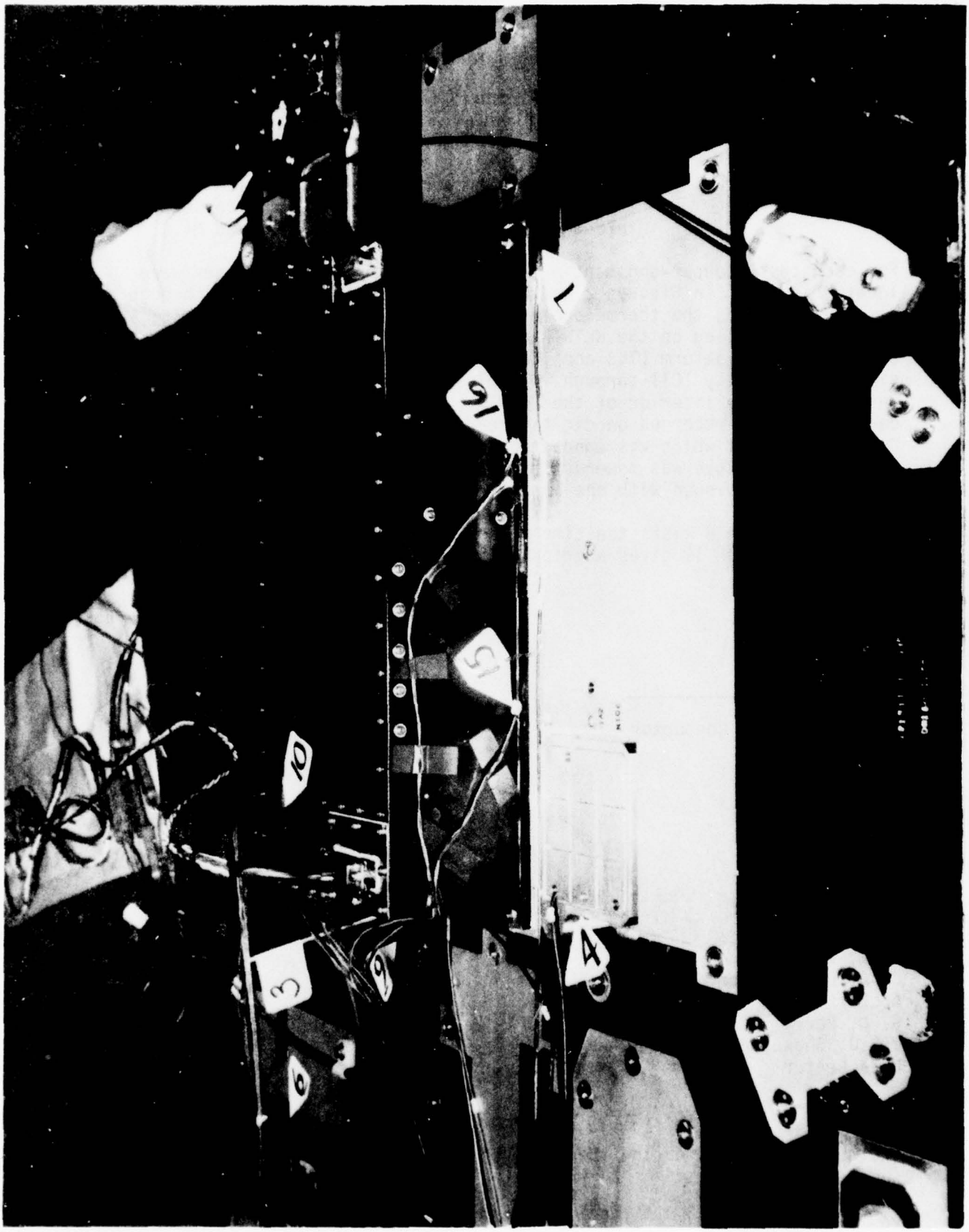
GEW:jw

Attachments

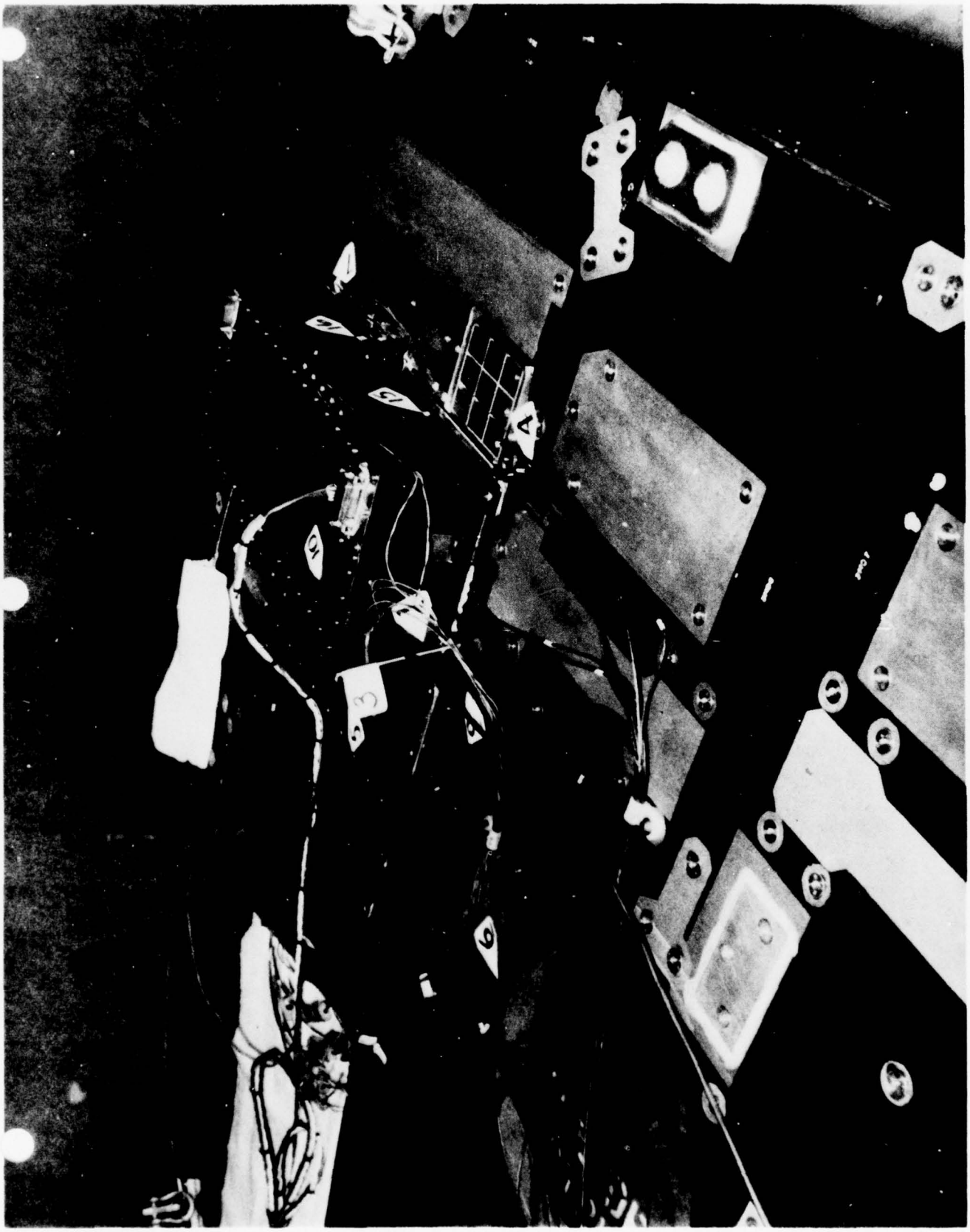
Distribution:

H. B. Benner
E. G. Couch
J. A. Durschinger
A. Parker
G. D. Perry
W.B.J. Shakespeare
Data Center

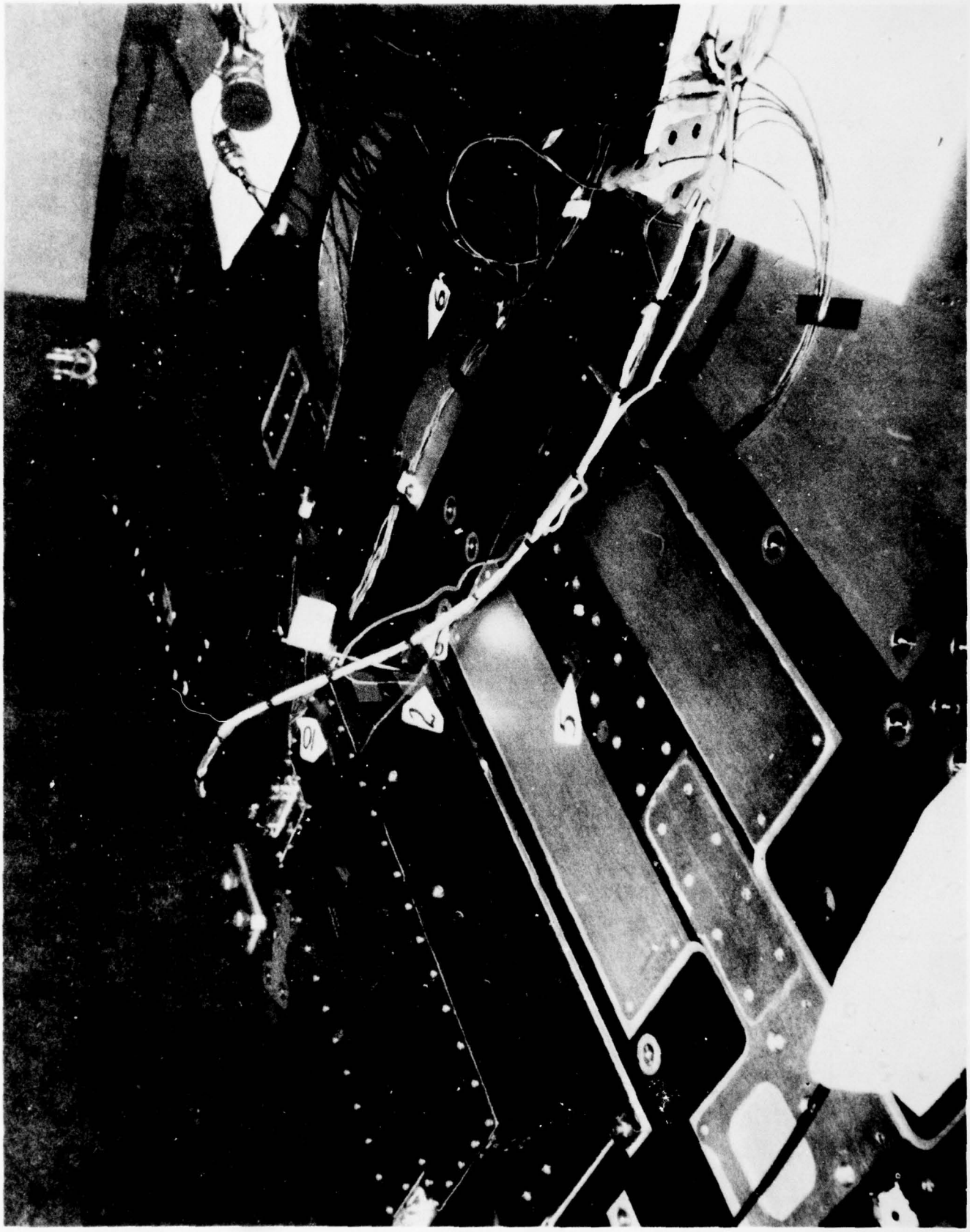
*TC10 was installed during the tests of configurations 6, 7, and 8 only.



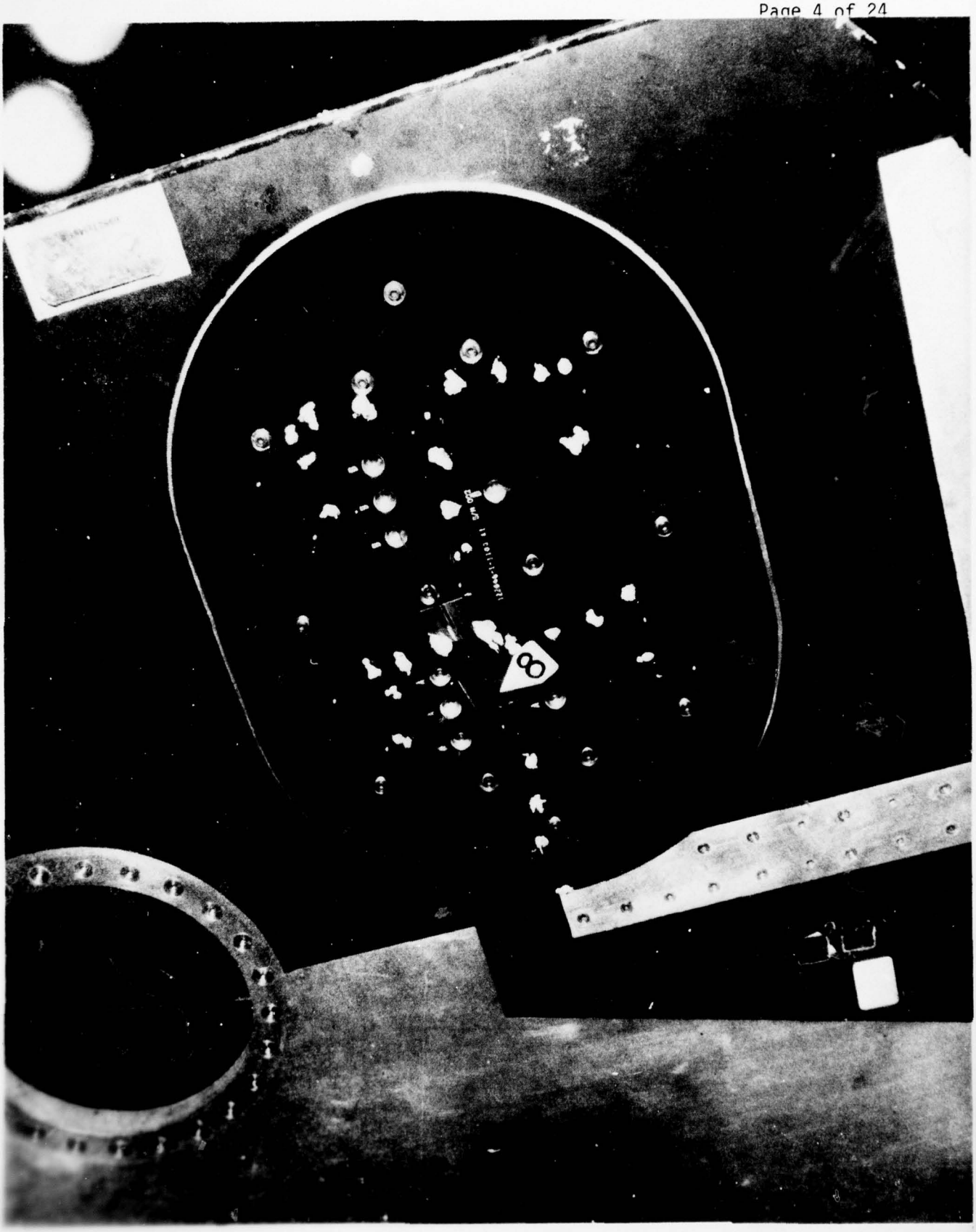
THERMOCOUP LOCATIONS
PHOTOGRAPH 1



THERMOCOUPLE LOCATIONS
PHOTOGRAPH 2

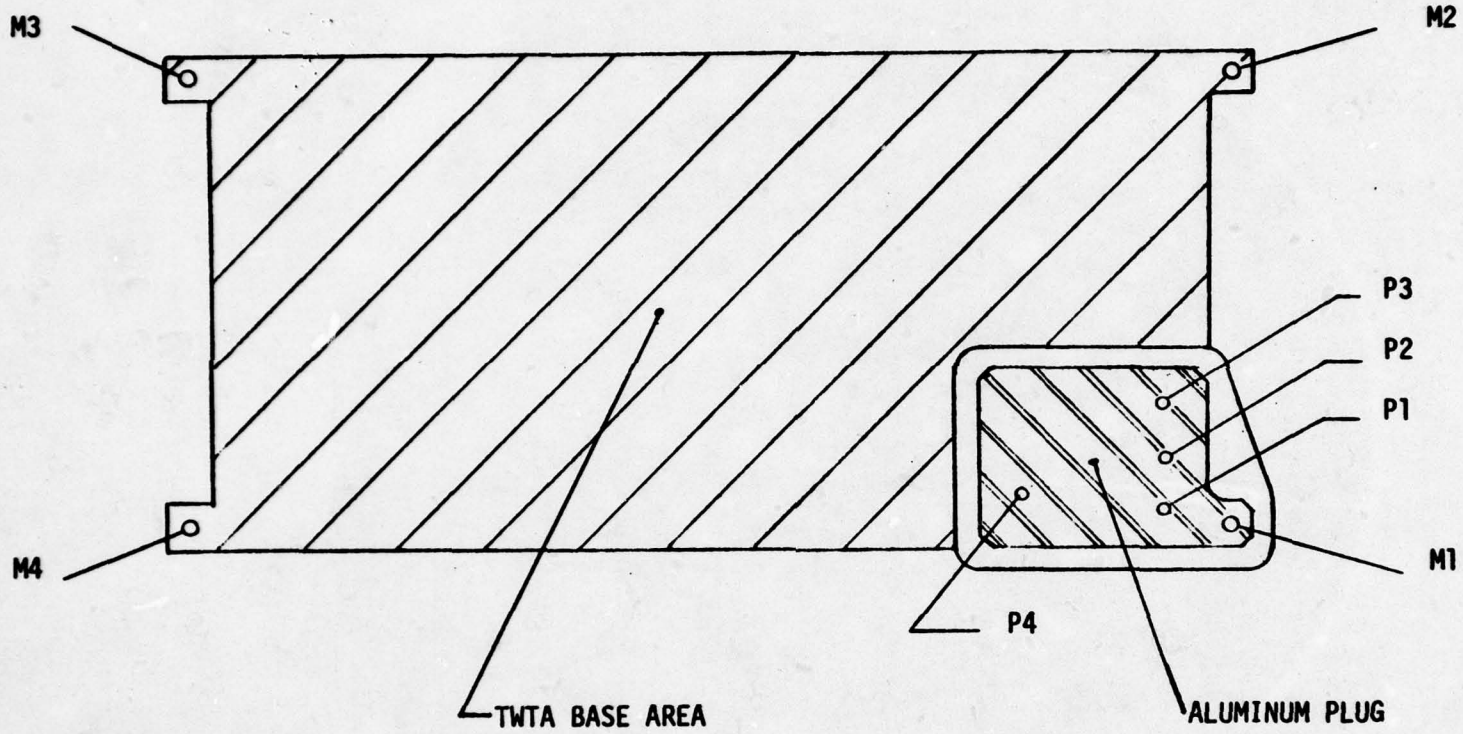


THERMOCOUPLE LOCATIONS
PHOTOGRAPH 3



THERMOCOUPLE 8 LOCATION

PHOTOGRAPH 4

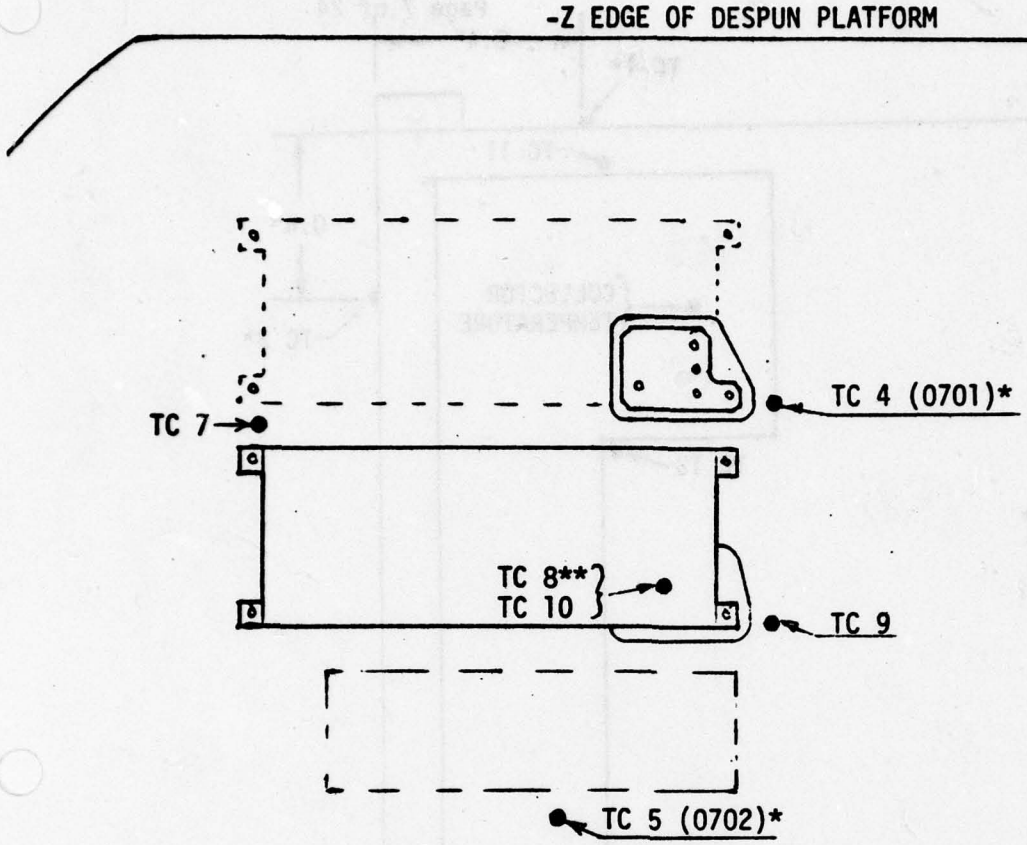


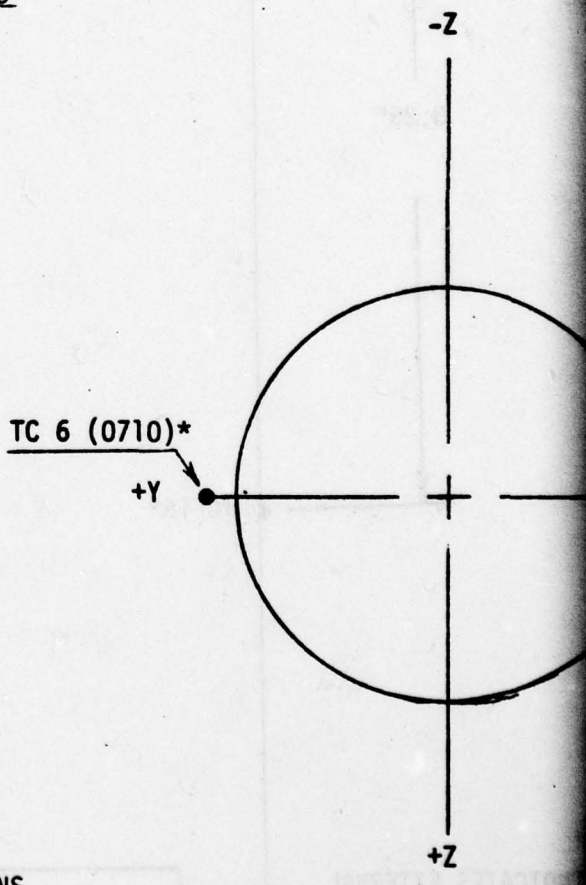
M1, M2, M3, M4 = HLTWTA MOUNTING LUGS (SCREWS INTO TOP OF PLATFORM)

P1, P2, P3, P4 = HLT TIEDOWN LOCATIONS (SCREWS THROUGH ALUMINUM PLUG INTO TUBE BASE)

DESPUN PLATFORM MOUNTING DETAILS

FIGURE 1





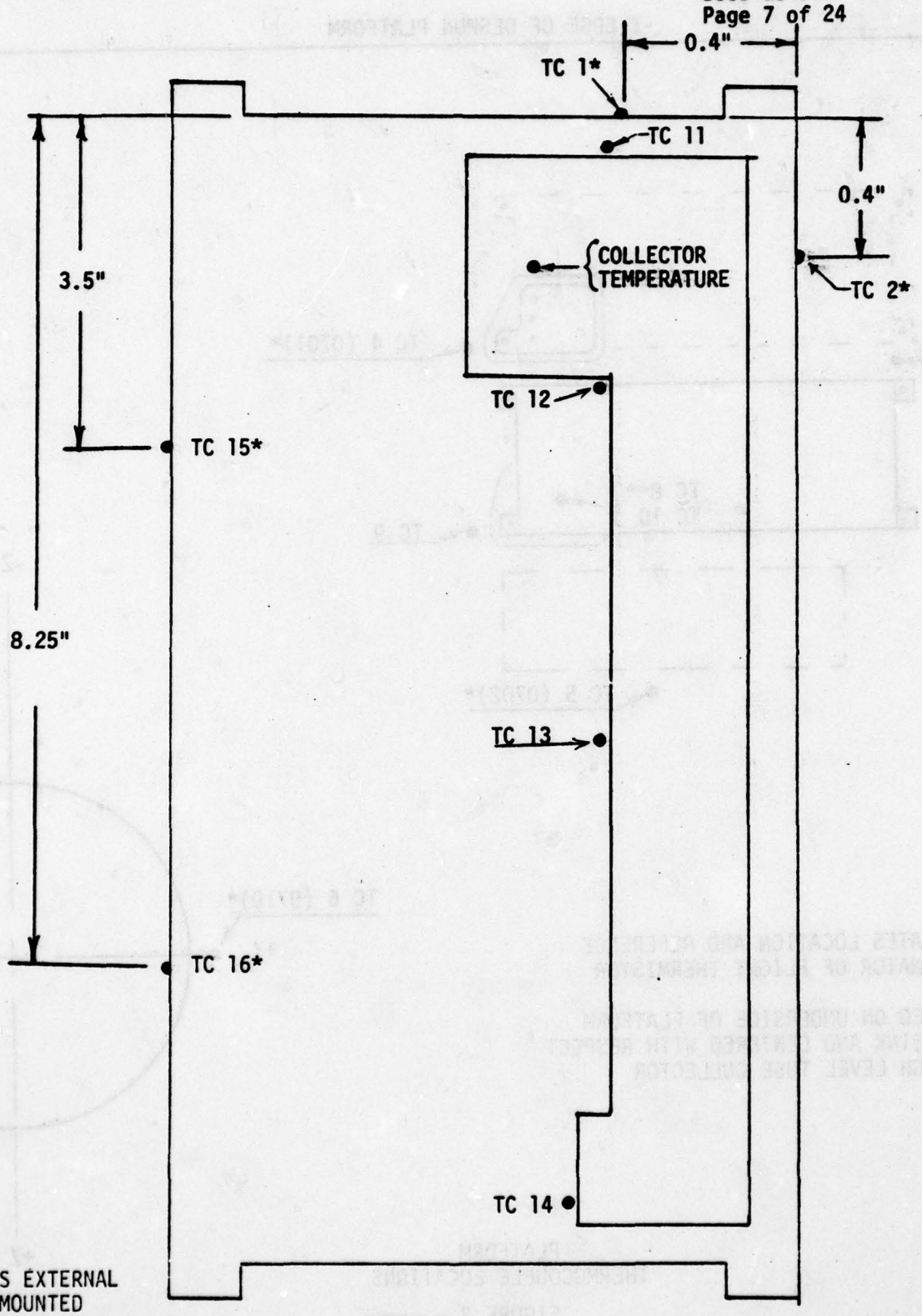
*INDICATES LOCATION AND REFERENCE DESIGNATOR OF FLIGHT THERMISTOR

**LOCATED ON UNDERSIDE OF PLATFORM HEAT SINK AND CENTERED WITH RESPECT TO HIGH LEVEL TUBE COLLECTOR

PLATFORM
THERMOCOUPLE LOCATIONS

FIGURE 2

8.2-2 Nov 4



*INDICATES EXTERNAL SURFACE MOUNTED SENSOR

INTERNAL
THERMOCOUPLE LOCATIONS

FIGURE 3

8.1-2 Vmm B

FIGURE 4
CONFIGURATION #1
COLLECTOR
TC 11 & TC 12
TC 8
TC 4
CHAMBER
TIME - MINUTES
TEMPERATURE - °F

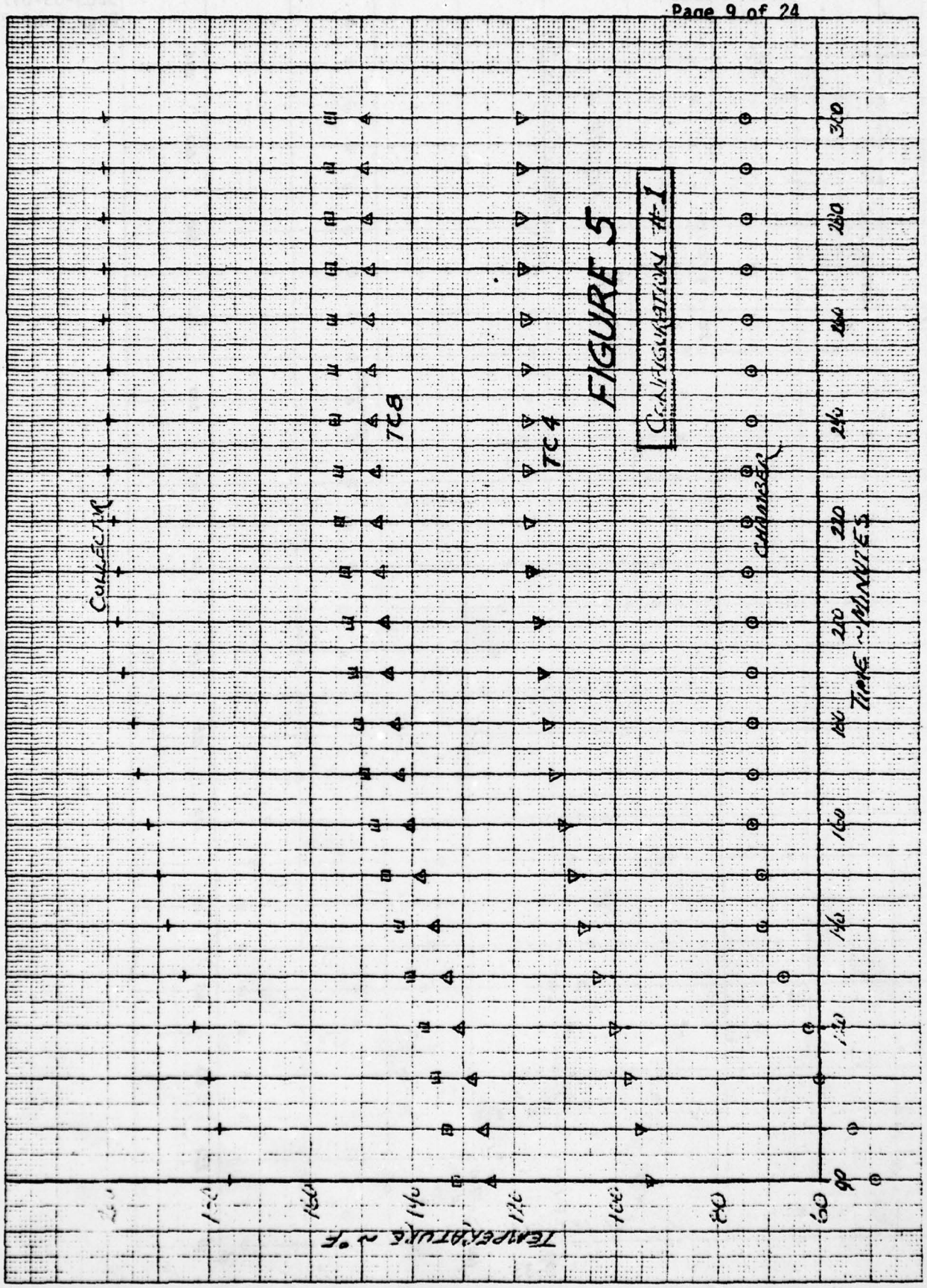


FIGURE 5
CONFIGURATION #-1
TC 4
TC 8
COLLECTOR
CHAMBER
TEMPERATURE ~ °F
TIME ~ MINUTES
60
90
120
150
180
210
240
270
300

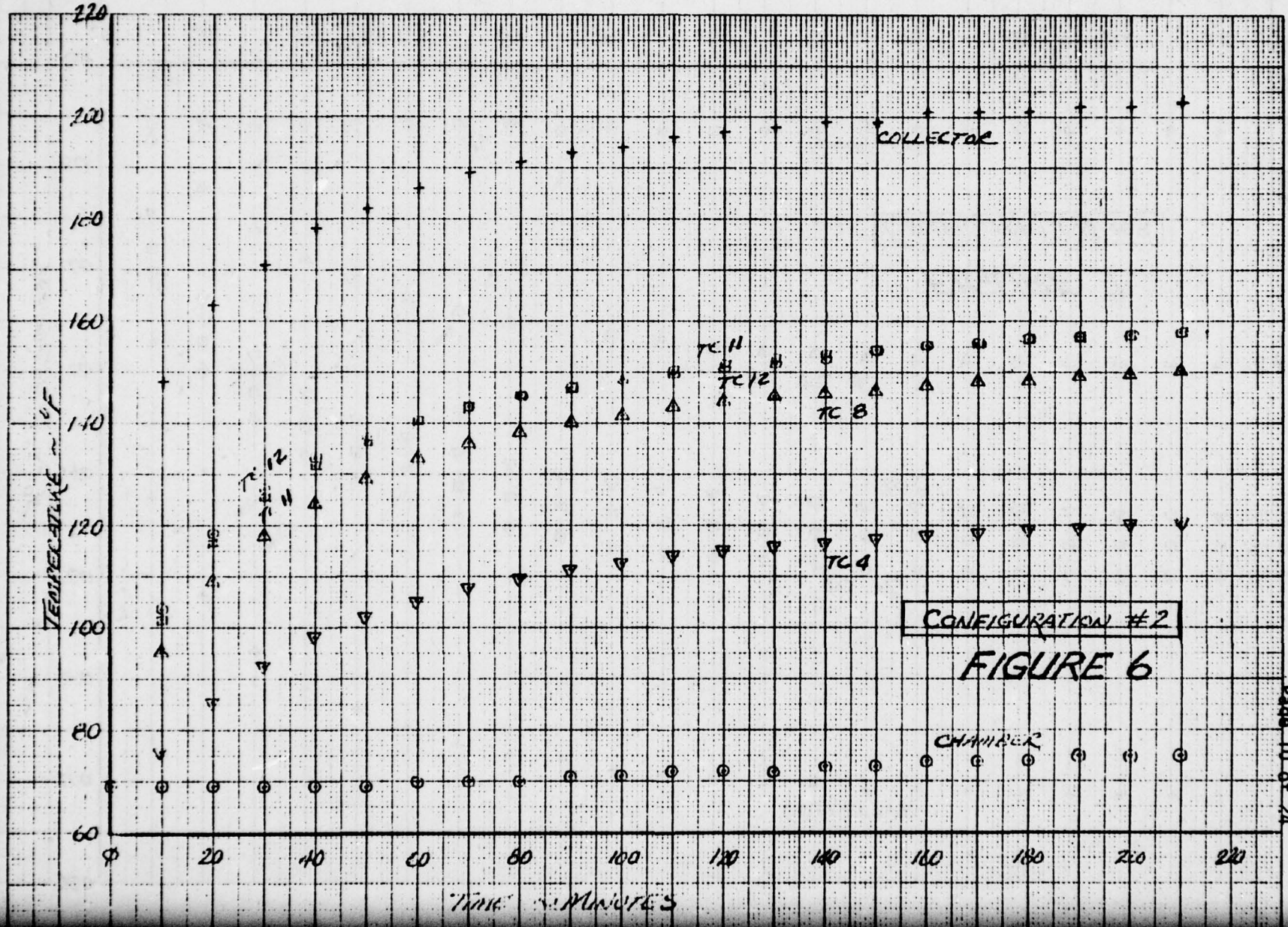

SQUARE 10 X 10 TO THE CENTIMETER AS-8014-GT
TEMPERATURE - °F
220
200
180
160
140
120
100
80
60
0
20
40
60
80
100
120
140
160
180
200
220
TIME - MINUTES
COLLECTOR
TC 11
TC 12
TC 8
TC 4
CHAMBER
CONFIGURATION #2

FIGURE 6

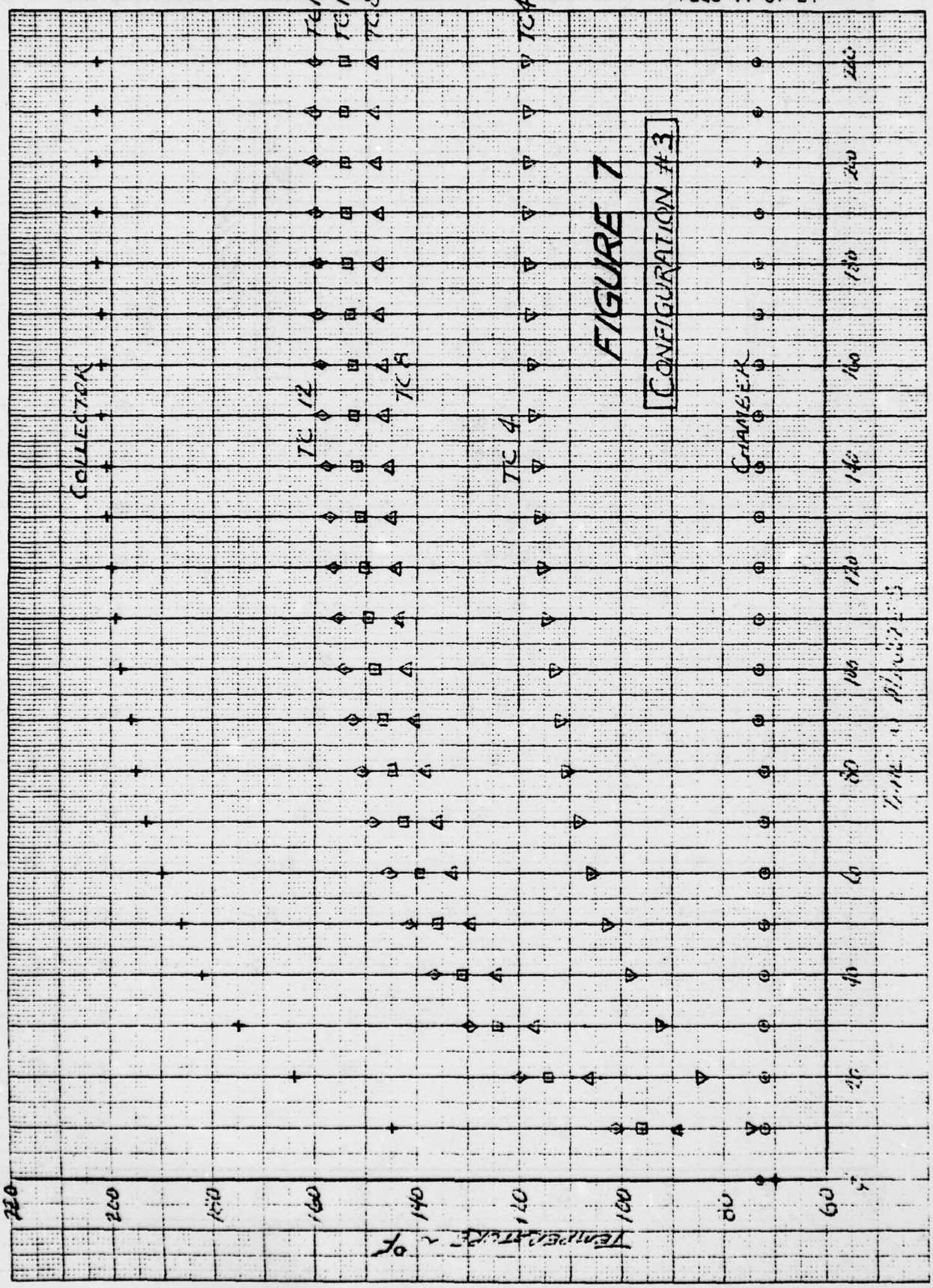


FIGURE 7
CONFIGURATION #3
COLLECTOR
GRAVITY
TC 12
TC 11
TC 8
TC 9
TC 4
TC 4
TEMPERATURE °F
220
200
180
160
140
120
100
80
60

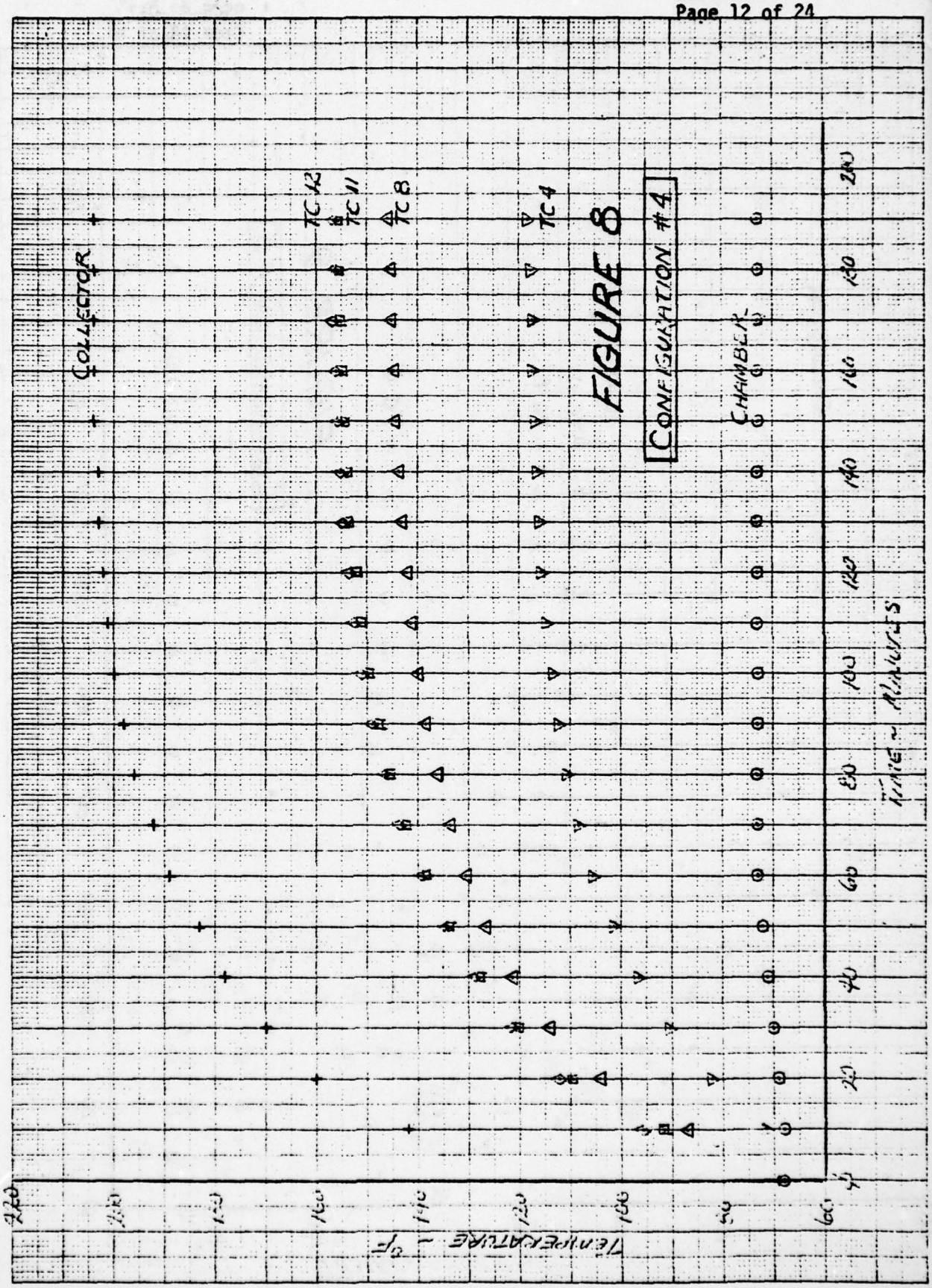


FIGURE 8
CONFIGURATION #4
COLLECTOR
CHAMBER
TC 12
TC 11
TC 8
TC 4
TEMPERATURE - °F
TIME - MINUTES
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20

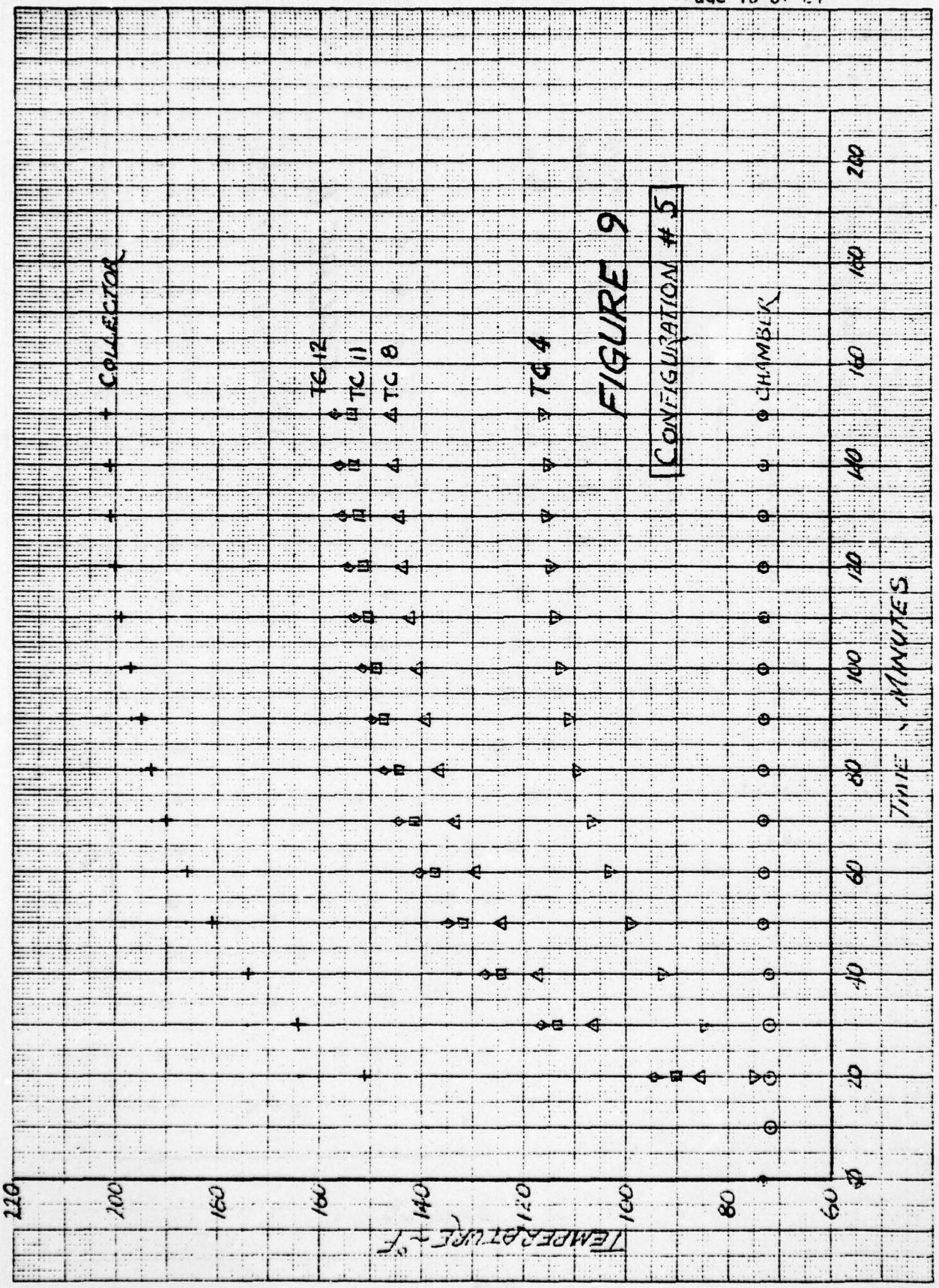


FIGURE 9
CONFIGURATION #5
COLLECTOR
TC 12
TC 11
TC 8
TC 4
CHAMBER
TEMPERATURE - °F
TIME - MINUTES
220
200
180
160
140
120
100
80
60
0
20
40
60
80
100
120
140
160
180
200

FIGURE 10
CONCENTRATION of 6
COLLECTOR
TC 12
TC 11
TC 9
TC 4
CHAMBER
TIME (MINUTES)
20
40
60
80
100
120
140
160

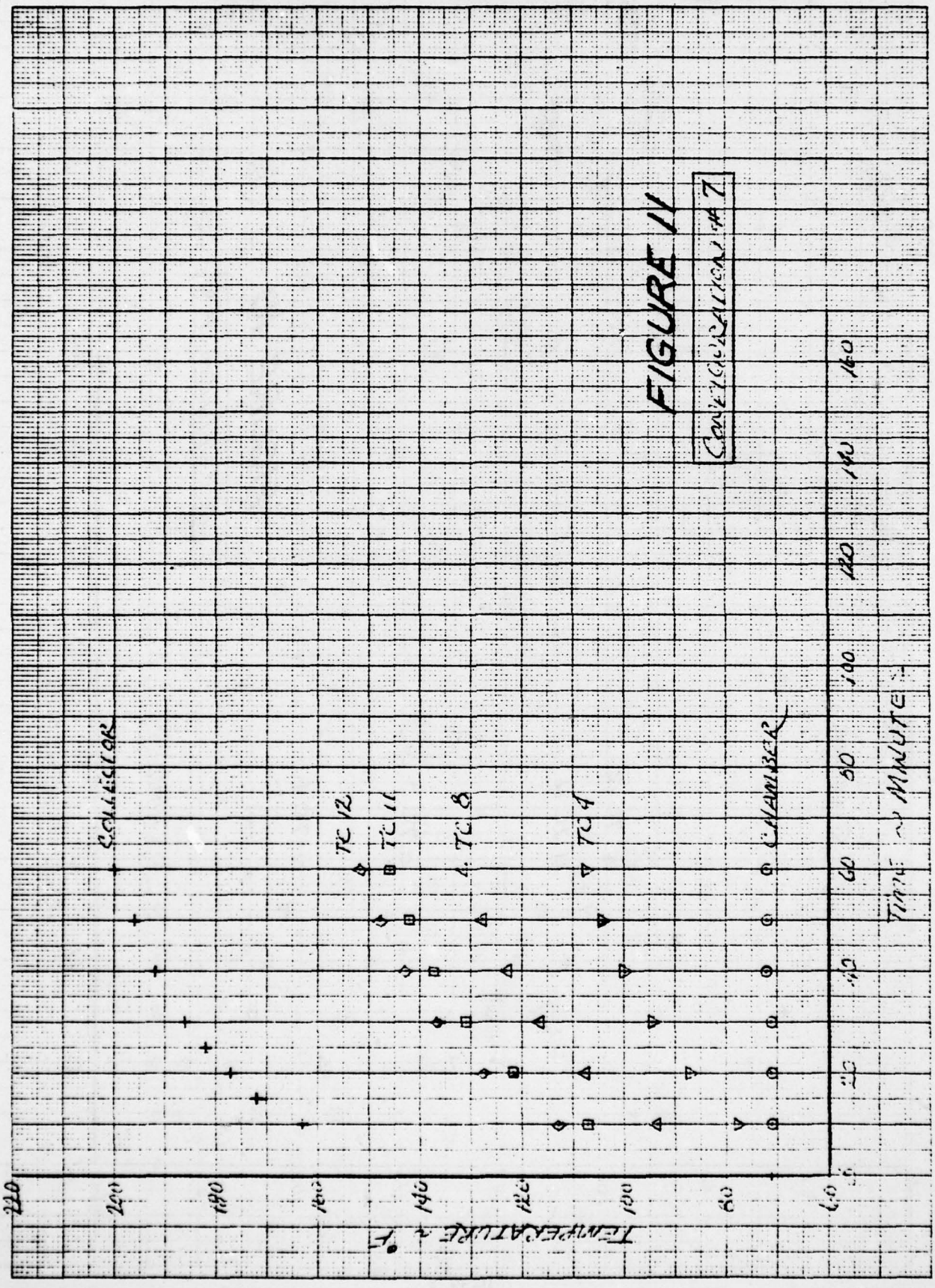


FIGURE 11
CONFIGURATION #7
TEMPERATURE - °F
TIME - MINUTES
CHAMBER
SOLDERS
TC 12
TC 11
TC 8
TC 4
220
200
180
160
140
120
100
80
60
40
20
0
30
60
90
120
150
180

SQUARE 10 X 10 TO THE CENTIMETER AS-8014 GT

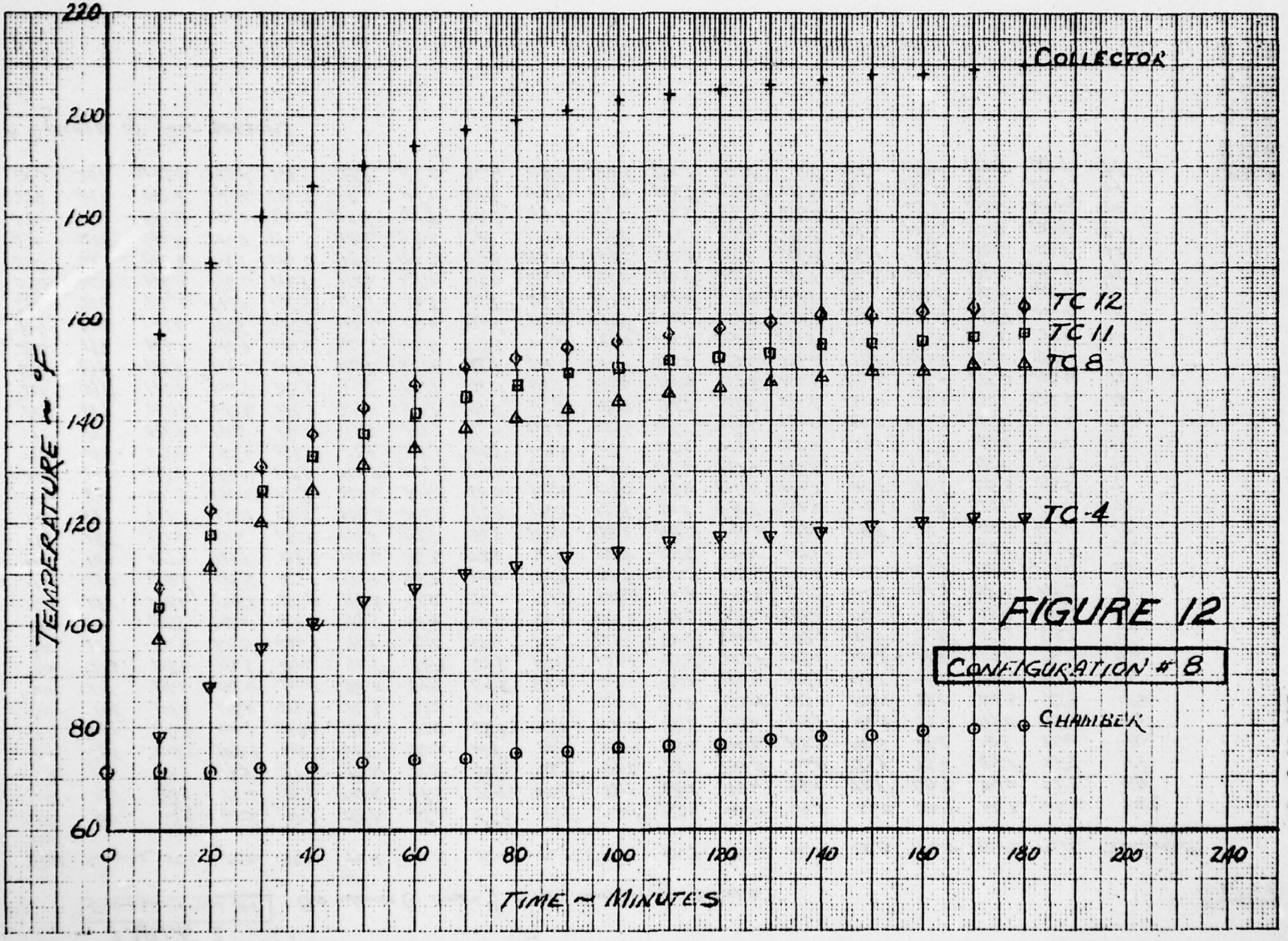


FIGURE 12

CONFIGURATION # 8

TABLE 1

CONFIGURATION #1 — ONE INDIUM (1 GASKET) & ALL 8 MOUNTING SCREWS

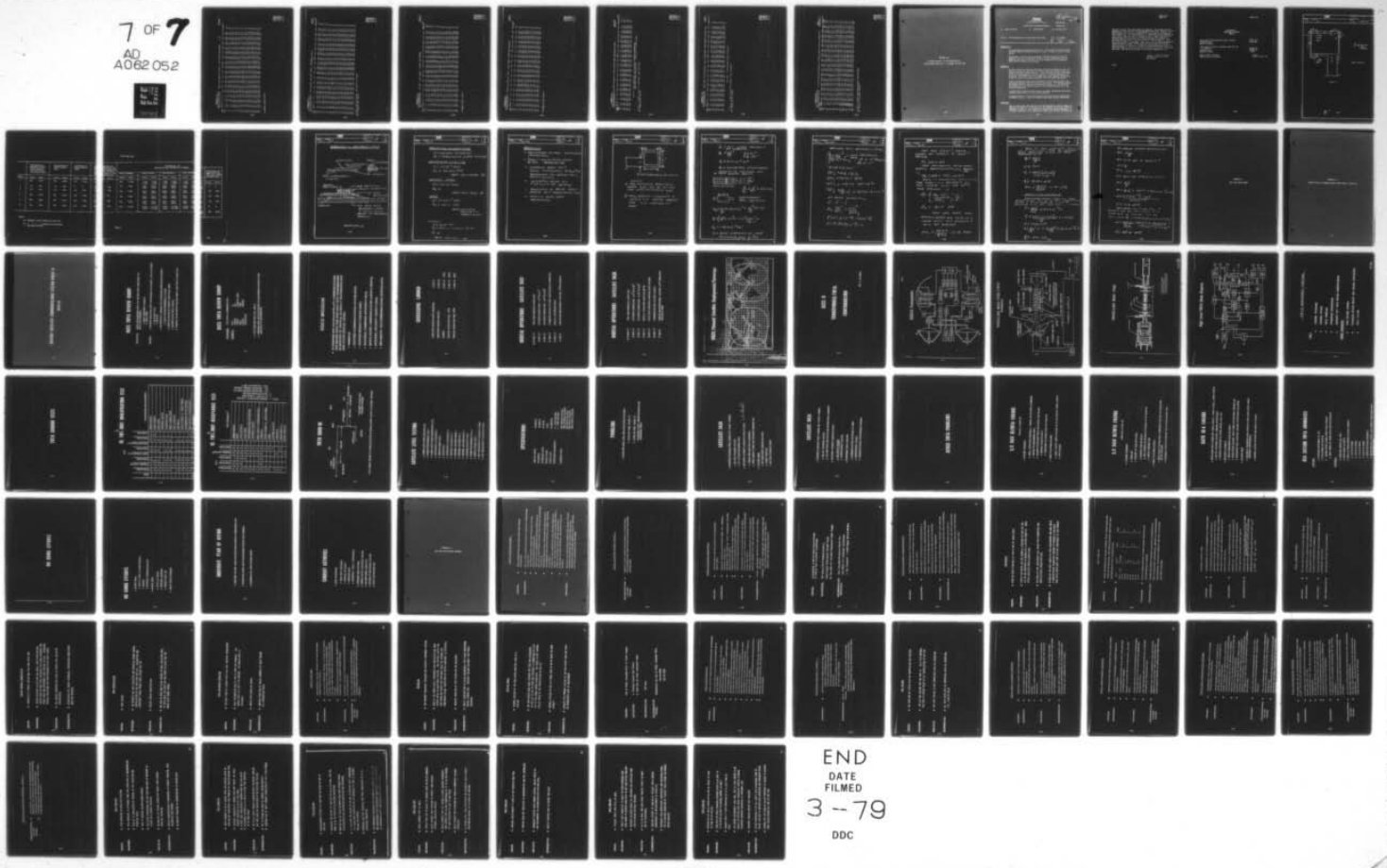
THURSDAY 7-21-77

TIME min	AMBIENT	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC11	TC12	TC13	TC14	TC15	TC16	THERMISTOR*
0	60	62.3	62.2	61.7	57.7	58.2	55.0	57.8	62.4	57.6	65.0	66.1	61.2	62.7	60.7	60.6	76.0
10	139	87.4	87.2	86.9	65.3	64.5	55.9	62.7	88.7	69.8	95.6	95.4	73.8	66.7	74.0	67.7	46
20	151	97.9	97.7	97.5	73.2	71.3	57.1	68.4	99.6	78.3	106.9	106.4	83.4	73.0	84.1	75.5	45
30	158	105.1	104.9	104.7	78.9	76.2	61.8	73.7	106.9	84.0	114.2	113.7	90.5	78.8	91.5	81.6	46
40	164	110.3	110.1	109.9	83.2	79.9	63.9	77.8	112.2	88.2	119.6	119.1	96.1	83.9	97.0	86.4	46
50	168	114.3	114.0	113.8	86.3	82.7	65.6	81.2	116.2	91.3	123.4	123.0	100.4	88.0	101.3	90.3	46
60	171	117.3	117.0	116.7	88.7	84.9	66.8	84.0	119.2	93.7	126.2	125.8	103.8	91.5	104.5	93.5	46
70	173	119.6	119.3	119.0	90.5	86.7	67.8	86.3	121.4	95.5	128.4	128.0	106.5	94.4	107.1	96.0	46
80	175	121.3	121.0	120.7	91.9	88.0	68.6	88.1	123.1	96.9	130.1	129.7	108.7	96.8	109.1	98.1	46
90	176	122.8	122.5	122.2	93.3	89.4	69.6	90.0	124.6	98.3	131.6	131.2	110.5	99.0	110.9	100.1	47
100	178	124.6	124.3	123.9	95.3	91.2	71.7	92.2	126.3	100.2	133.3	132.9	112.5	101.3	112.9	102.3	53
110	180	126.8	126.5	126.1	97.9	93.7	74.6	94.9	128.5	102.9	135.5	135.0	114.8	103.9	115.3	105.0	60
120	183	129.1	128.9	128.5	100.6	96.3	77.5	97.5	130.9	105.5	137.9	137.3	117.3	106.5	117.8	107.5	62
130	185	131.5	131.2	130.8	103.1	98.8	80.3	100.0	133.2	108.0	140.2	139.6	119.8	109.1	120.3	110.1	67
140	188	134.1	133.9	133.5	106.2	101.8	83.7	102.9	135.9	111.1	142.8	142.2	122.5	111.9	123.0	113.0	71
150	190	136.5	136.2	135.9	108.6	104.3	86.2	105.4	138.3	113.6	145.3	144.7	124.9	114.5	125.3	115.5	71
160	192	138.5	138.3	138.0	110.7	106.5	88.2	107.4	140.4	115.6	147.4	146.8	127.1	116.8	127.5	117.7	73
170	194	140.3	140.0	139.7	112.4	108.3	89.8	109.3	142.1	117.3	149.1	148.6	129.0	118.9	129.3	119.6	73
180	195	141.7	141.5	141.1	113.7	109.7	91.0	110.8	143.6	118.7	150.6	150.1	130.7	120.7	130.8	121.2	73
190	197	142.8	142.6	142.3	114.7	110.8	91.8	112.1	144.7	119.7	151.8	151.4	132.0	122.1	132.1	122.5	73
200	198	143.8	143.5	143.2	115.5	111.7	92.4	113.1	145.6	120.6	152.8	152.3	133.2	123.4	133.2	123.6	73
210	198	144.5	144.3	144.0	116.2	112.4	92.9	114.0	146.4	121.2	153.6	153.2	134.1	124.5	134.0	124.5	74
220	199	145.1	144.9	144.6	116.7	113.0	93.3	114.8	147.0	121.7	154.2	153.8	134.9	125.4	134.8	125.3	74
230	200	145.6	145.5	145.1	117.2	113.4	93.5	115.4	147.5	122.1	154.8	154.4	135.6	126.2	135.4	126.0	74
240	200	146.0	145.9	145.5	117.5	113.8	93.7	115.9	147.9	122.4	155.2	154.8	136.1	126.8	135.8	126.5	73
250	200	146.3	146.2	145.8	117.6	114.0	93.7	116.2	148.2	122.5	155.5	155.1	136.6	127.3	136.2	126.9	73
260	201	146.6	146.5	146.0	117.9	114.3	94.0	116.7	148.5	122.8	155.8	155.4	136.9	127.9	136.6	127.4	74
270	201	146.9	146.7	146.3	118.2	114.6	94.2	117.1	148.8	123.1	156.0	155.7	137.3	128.3	136.9	127.8	74
280	201	147.2	147.0	146.5	118.4	114.8	94.4	117.4	149.0	123.3	156.3	156.0	137.6	128.7	137.2	128.2	74
290	201	147.4	147.2	146.7	118.6	115.0	94.5	117.7	149.3	123.5	156.5	156.3	137.9	129.1	137.5	128.4	74
300	201	147.6	147.4	146.9	118.8	115.2	94.6	118.0	149.4	123.7	156.8	156.5	138.2	129.4	137.7	128.7	74

* Average of four sensors

AD-A062 052 TRW DEFENSE AND SPACE SYSTEMS GROUP REDONDO BEACH CALIF F/G 9/1
9438 HIGH LEVEL TRAVELING WAVE TUBE AMPLIFIER ANOMALY. VOLUME I--ETC(U)
AUG 78 J A DURSCHINGER F04701-75-C-0257
UNCLASSIFIED TRW-28600-AR-015-01-VOL-2 SAMSO-TR-77-184-VOL-2-REV- NL

7 OF 7
AD
A062 052



END
DATE
FILMED
3-79
DDC

TABLE 2

CENTRIFUGATION #2. One INDIUM GASKET (-1 GASKET) ONLY 3 SCREWS THRU PLATFORM

WEDNESDAY 7-22-77

Time min	Chuck	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC11	TC12	TC13	TC14	TC15	TC16	Trunnion*
0	70	69.8	69.7	69.7	69.6	69.6	69.4	69.5	69.3	69.3	69.2	69.2	69.4	69.5	69.4	69.5	69
10	148	94.2	94.1	93.5	76.0	75.0	70.8	72.2	95.3	79.5	101.8	103.6	80.1	73.3	80.9	75.7	69
20	163	107.8	107.8	107.5	85.6	83.6	75.3	79.1	109.4	90.4	116.4	118.3	92.1	80.5	93.4	85.0	69
30	171	116.8	116.7	116.5	92.8	89.9	78.9	85.4	118.6	97.7	125.5	127.3	101.1	87.4	102.6	92.7	69
40	178	123.1	123.1	122.8	98.1	94.7	81.8	90.6	124.9	103.1	131.8	133.7	108.1	93.8	109.6	98.8	69
50	182	127.7	127.7	127.4	102.2	98.5	84.1	95.0	129.6	107.1	136.6	137.5	113.5	99.4	114.9	103.6	69
60	186	131.3	131.3	131.0	105.4	101.4	85.9	98.6	133.3	110.3	140.4	140.8	117.8	104.4	119.2	107.7	70
70	189	134.1	134.2	133.8	107.9	103.8	87.3	101.6	136.2	112.8	143.4	143.5	121.3	108.4	122.5	110.0	70
80	191	136.4	136.5	136.0	109.9	105.7	88.5	104.1	138.4	114.8	145.8	145.3	124.1	111.7	125.1	113.8	70
90	193	138.3	138.4	137.9	111.6	107.3	89.5	106.3	140.3	116.4	147.7	147.0	126.3	114.6	127.2	116.2	71
100	194	139.8	140.0	139.4	112.9	108.7	90.4	108.1	141.9	117.8	149.3	148.6	128.3	117.1	129.1	118.2	71
110	196	141.1	141.3	140.7	114.1	109.8	91.1	109.8	143.2	118.9	150.6	149.8	130.0	119.2	130.6	120.0	72
120	197	142.2	142.4	141.8	115.1	110.8	91.8	111.2	144.3	119.9	151.8	151.0	131.4	121.0	132.0	121.5	72
130	198	143.2	143.4	142.8	116.0	111.7	92.4	112.4	145.3	120.7	152.8	151.9	132.7	122.6	133.1	122.8	72
140	199	144.1	144.3	143.6	116.7	112.5	92.9	113.5	146.1	121.4	153.6	152.8	133.8	124.0	134.1	123.7	73
150	199	144.8	145.1	144.4	117.4	113.2	93.5	114.6	146.9	122.1	154.4	154.6	134.7	125.2	134.9	124.9	73
160	201	145.5	145.8	145.1	118.1	113.9	94.0	115.5	147.6	122.7	155.2	155.3	135.6	126.3	135.7	125.9	74
170	201	146.2	146.4	145.8	118.7	114.5	94.4	116.3	148.3	123.3	155.8	155.9	136.4	127.3	136.5	126.7	74
180	201	146.7	147.0	146.3	119.2	115.0	94.9	117.0	148.9	123.8	156.4	156.6	137.1	128.2	137.1	127.5	74
190	202	147.3	147.6	146.9	119.7	115.6	95.3	117.7	149.4	124.3	157.0	157.1	137.7	129.0	137.7	128.2	75
200	202	147.8	148.0	147.3	120.2	116.0	95.7	118.4	149.9	124.8	157.5	157.6	138.4	129.7	138.3	128.8	75
210	203	148.3	148.6	147.8	120.7	116.5	96.1	119.0	150.4	125.2	158.0	158.1	138.9	130.4	138.9	129.4	75

* Average of four sensors

TABLE 3

CONFIGURATION #3 — FLITE MOUNTING PER DRWG 3105II & PROCEDURE DE-2US-11

NICADAY 7-25-77

Time min.	Course	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	TC 8	TC 9	TC 10*	TC 11	TC 12	TC 13	TC 14	TC 15	TC 16	Tenmode**
0	70	70.0	69.9	69.9	70.5	70.2	71.1	69.8	69.4	70.0	72.6	69.3	69.1	69.0	68.9	69.4	69.6	73
10	145	87.8	87.8	87.6	74.3	73.3	71.8	71.4	89.5	76.7	71.8	96.4	101.7	77.3	71.4	77.1	73.4	72
20	164	106.1	106.2	104.6	84.6	82.8	76.2	78.1	106.8	89.7	72.4	114.2	119.8	91.0	79.0	91.0	83.3	72
30	175	116.0	116.2	114.7	92.6	87.8	80.3	84.9	117.2	98.1	73.0	124.3	129.8	101.1	86.5	101.3	91.7	72
40	182	122.8	123.0	121.8	98.4	95.1	83.3	90.6	124.3	104.1	73.6	131.1	136.7	108.7	93.2	108.9	98.3	72
50	186	127.6	127.8	126.8	102.8	99.0	85.6	95.2	129.3	108.4	73.9	136.0	141.8	114.6	98.8	114.7	103.5	72
60	190	131.3	131.5	130.6	106.0	102.0	87.3	98.9	133.2	111.6	74.3	139.7	145.6	119.3	103.8	119.1	107.7	72
70	193	134.1	134.3	133.5	108.5	104.3	88.7	101.9	136.2	114.2	74.6	142.6	148.6	122.8	108.2	122.4	111.1	72
80	195	136.3	136.5	135.8	110.4	106.2	89.7	104.5	138.5	116.2	75.0	144.9	150.9	125.6	111.9	125.1	113.9	72
90	196	138.2	138.4	137.6	112.1	107.8	90.8	106.7	140.4	117.8	75.7	146.7	152.7	127.8	115.1	127.3	116.3	73
100	198	139.7	139.9	139.1	113.1	109.1	91.5	108.6	142.0	119.2	76.0	148.2	154.2	129.7	117.5	129.1	118.3	73
110	199	141.0	141.1	140.4	114.5	110.1	92.2	110.1	143.2	120.3	76.2	149.4	155.4	131.3	119.6	130.6	120.1	73
120	200	141.9	142.2	141.4	115.3	111.0	92.7	111.4	144.3	121.1	76.4	150.4	156.4	132.6	121.3	131.8	121.4	73
130	201	142.7	143.0	142.2	116.0	111.7	93.1	112.5	145.1	121.7	76.5	151.2	157.2	133.7	122.7	132.8	122.6	73
140	201	143.4	143.7	142.9	116.6	112.3	93.4	113.5	145.8	122.3	76.6	151.9	157.9	134.6	123.9	133.7	123.6	73
150	202	144.0	144.3	143.4	117.1	112.7	93.6	114.3	146.4	122.7	76.6	152.4	158.5	135.5	125.0	134.4	124.4	73
160	202	144.4	144.8	143.9	117.4	113.1	93.8	115.0	146.9	123.1	76.8	152.7	159.0	136.1	125.9	134.9	125.1	73
170	202	144.9	145.2	144.3	117.8	113.4	94.0	115.6	147.3	123.4	76.8	153.3	159.4	136.7	126.6	135.5	125.7	73
180	203	145.2	145.6	144.6	118.1	113.8	94.2	116.2	147.6	123.7	77.0	153.6	159.7	137.2	127.3	135.9	126.3	73
190	203	145.5	145.9	144.9	118.3	114.0	94.3	116.6	147.9	124.0	77.0	153.9	160.0	137.6	127.9	136.3	126.7	73
200	203	145.7	146.2	145.2	118.5	114.2	94.4	117.1	148.2	124.2	77.2	154.2	160.3	138.0	128.4	136.6	127.1	73
210	203	145.9	146.4	145.4	118.7	114.4	94.5	117.4	148.4	124.4	77.1	154.3	160.5	138.3	128.9	136.9	127.5	73
220	203	146.2	146.6	145.6	118.8	114.6	94.6	117.7	148.6	124.5	77.1	154.5	160.7	138.6	129.3	137.1	127.8	73

* TC 10 FREE IN CHAMBER NEAR TUBE (~ 18" AWAY)

** Average of four sensors

TABLE 4

Configuration #4 — All RTV — 4 gold screens — 3 screws TAKU platform

TUESDAY 7-26-77

Time (min)	Collector	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC11	TC12	TC13	TC14	TC15	TC16	Thermistor*
0	69	68.6	68.6	68.5	68.5	68.5	68.5	68.4	68.2	68.2	68.1	68.0	68.2	68.3	68.3	63.8	68
10	142	86.1	86.7	85.3	71.8	71.0	68.9	69.6	87.0	73.8	91.6	95.8	74.6	70.2	75.4	71.6	68
20	160	102.8	103.9	102.2	82.2	80.5	73.1	76.2	104.2	86.6	109.6	112.1	88.0	77.3	89.4	81.6	69
30	170	113.0	114.2	112.3	90.4	87.7	77.5	83.1	114.3	95.0	120.4	121.2	98.0	84.6	99.8	90.0	70
40	178	120.6	121.8	119.4	96.7	93.1	81.0	87.0	121.4	101.8	128.2	128.4	105.9	91.3	107.8	96.9	71
50	183	126.1	127.5	124.6	101.4	97.5	83.9	94.0	126.6	105.8	134.0	134.4	112.1	97.2	114.0	102.5	72
60	189	130.6	132.0	128.6	105.5	101.0	86.4	98.1	130.7	109.5	138.9	139.4	117.3	102.5	119.0	107.1	73
70	192	134.2	135.7	131.8	108.2	103.8	88.2	101.6	133.8	112.5	142.7	143.4	121.4	107.3	122.8	110.9	73
80	196	137.0	138.6	134.3	110.4	105.9	89.6	104.4	136.3	114.6	145.8	146.5	124.6	111.3	125.8	114.0	73
90	198	139.1	140.8	136.3	112.1	107.7	90.6	106.7	138.4	116.4	148.1	149.0	127.2	114.6	128.2	116.5	73
100	200	140.9	142.5	137.9	113.5	109.0	91.3	108.6	140.0	117.8	149.9	150.9	129.3	117.4	130.1	118.7	73
110	201	142.2	143.9	139.2	114.6	110.0	91.9	110.3	141.3	118.7	151.3	152.4	131.0	119.7	131.7	120.4	73
120	202	143.3	145.0	140.2	115.6	110.9	92.3	111.6	142.3	119.6	152.5	153.6	132.4	121.5	132.9	121.8	73
130	203	144.1	145.8	141.0	116.0	111.5	92.6	112.6	143.1	120.2	153.2	154.4	133.5	122.9	133.9	123.0	73
140	203	144.8	146.5	141.6	116.5	112.0	92.8	113.6	143.8	120.7	153.9	155.1	134.4	124.1	134.7	123.9	73
150	204	145.3	147.1	142.1	116.9	112.4	92.9	114.4	144.3	121.0	154.4	155.6	135.2	125.2	135.4	124.7	73
160	204	145.7	147.5	142.6	117.3	112.8	93.1	115.0	144.8	121.4	154.8	156.0	135.8	126.0	135.9	125.4	73
170	204	146.1	147.9	143.0	117.5	113.1	93.2	115.7	145.2	121.7	155.1	156.3	136.3	126.8	136.4	126.0	73
180	204	146.4	148.3	143.3	117.9	113.3	93.4	116.2	145.5	122.0	155.4	156.6	136.8	127.5	136.8	126.5	73
190	204	146.7	148.5	143.6	118.1	113.6	93.5	116.6	145.9	122.2	155.6	156.8	137.2	128.0	137.2	126.9	73

* Average of four sensors

TABLE 5

Configuration #5 — Same as Config. #2 (one + Indium Gasket, 3 screws thru platform)

Tuesday 7-26-77

Time min.	Column	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC11	TC12	TC13	TC14	TC15	TC16	T Chamber*
0	73	73.6	73.5	73.5	73.5	73.5	73.5	73.4	73.2	73.2	73.1	73.1	73.1	73.2	73.3	73.3	73
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	151	84.2	84.5	83.9	74.6	74.3	73.6	73.8	85.4	75.2	90.3	94.1	76.3	74.0	76.8	74.7	72
30	164	103.7	104.4	104.3	84.4	83.2	76.7	79.3	106.2	88.8	113.5	116.6	90.4	80.3	91.3	84.2	72
40	174	116	115.1	115.1	92.8	90.5	80.6	86.0	117.2	97.5	124.5	127.4	100.9	87.5	102.0	92.8	72
50	181	121.9	122.4	122.5	98.9	95.7	83.8	91.7	124.6	103.6	132.0	134.8	108.7	94.1	110.0	99.5	73
60	186	127.1	127.5	127.7	103.4	100.0	86.2	96.4	129.9	108.2	137.5	140.2	114.8	99.7	115.9	104.8	73
70	190	131.0	131.5	131.6	106.8	103.2	88.0	100.1	133.9	111.6	141.5	144.4	119.4	104.7	120.4	109.0	73
80	193	134.0	134.5	134.6	109.3	105.6	89.4	103.2	136.9	114.1	144.7	147.5	123.0	109.1	123.7	112.4	73
90	195	136.3	136.8	136.9	111.3	107.5	90.4	105.6	139.3	116.0	147.1	150.0	125.8	112.9	126.3	115.1	73
100	197	138.2	138.6	138.7	112.8	108.9	91.2	107.7	141.1	117.6	149.0	151.9	128.0	116.2	128.4	117.3	73
110	199	139.6	140.0	140.0	113.9	110.0	91.8	109.4	142.5	118.7	150.4	153.4	129.8	118.7	130.0	119.2	73
120	200	140.7	141.1	141.1	114.8	110.9	92.3	110.8	143.6	119.6	151.6	154.5	131.2	120.7	131.3	120.7	73
130	201	141.6	142.1	142.0	115.5	111.6	92.6	111.9	144.5	120.4	152.5	155.5	132.4	122.3	132.4	121.9	73
140	201	142.4	142.9	142.8	116.1	112.2	92.9	112.9	145.4	121.0	153.3	156.3	133.5	123.6	133.2	123.0	73
150	202	143.0	143.5	143.4	116.6	112.7	93.2	113.8	146.0	121.4	153.9	157.0	134.3	124.6	133.9	123.8	73

* Average of four sensors

TABLE 6

CONFIGURATION #6 — ALL RTV, 4 SCREWS AT FEET, NO THRU SCREWS FROM BOTTOM OF TUBE

THURSDAY 9-28-77

TIME (MINS)	COLLECTOR	TC 1	TC 2	TC 3	TC 4	TC 5	TC 6	TC 7	TC 8	TC 9	TC 10*	TC 11	TC 12	TC 13	TC 14	TC 15	TC 16	TUBE#**
0	72	71.6	71.5	71.5	71.7	71.7	71.9	71.2	71.2	71.3	71.2	71.0	70.9	70.9	70.7	71.1	71.1	72
10	166	94.3	94.9	90.4	76.5	75.5	72.9	73.5	91.3	79.0	80.5	107.1	118.6	82.1	73.1	80.6	76.2	72
20	188	112.8	113.8	103.9	86.2	84.1	76.9	80.5	105.0	90.2	94.0	130.3	140.3	97.0	79.8	94.5	86.2	72
25	195	119.0	120.0	108.6	90.2	87.5	78.8	84.0	109.8	94.2	99.0	137.2	147.0	102.8	83.7	100.0	90.5	72
30	200	123.1	124.8	112.7	93.7	90.5	80.5	87.2	113.9	97.6	103.3	142.5	152.3	107.7	87.5	104.8	94.4	72
35	204	127.8	128.7	116.0	96.7	93.1	82.0	90.2	117.3	100.6	107.0	147.2	156.9	112.1	91.1	108.9	97.9	72
40	208	131.0	132.2	119.0	99.3	95.4	83.3	92.9	120.3	103.1	110.2	151.0	160.8	115.8	94.5	112.5	100.9	72

TUBE OF - TEST TERMINATED DUE TO RISING COLLECTOR TEMPERATURE
PROJECTED COLLECTOR TEMPERATURE 225° TO 230° F AT STEADY STATE

* TC 10 LOCATED ON TOP OF TUBE ASSY OVER COLLECTOR
** Average of four sensors

TABLE 7

CONFIGURATION #7 — BARE TUBE-TO-ALUMINUM PLUG WITH 3 THRU SCREWS FROM BOTTOM, RTV & GOLD SCREWS — FRIDAY 7-29-77

TIME MIN	COLLECTOR	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10*	TC11	TC12	TC13	TC14	TC15	TC16	TUNNEL**
0	71	71.4	71.3	71.3	71.3	71.3	71.3	71.2	71.0	71.0	71.1	70.9	70.8	71.0	71.2	71.1	71.1	71
10	163	99.5	100.7	92.2	77.6	76.4	72.6	74.2	93.6	80.3	83.4	107.1	112.9	82.9	73.9	83.3	77.7	71
15	172	107.3	108.5	100.0	82.5	81.0	74.7	77.7	101.6	86.3	89.5	115.6	121.3	89.6	77.1	90.2	82.6	71
20	177	113.3	114.5	106.1	87.1	85.0	76.8	81.1	107.7	91.2	94.6	121.9	127.3	95.4	80.7	96.1	87.2	71
25	182	118.2	119.4	111.0	91.0	88.4	78.8	84.5	112.6	95.2	98.9	126.7	132.2	100.4	84.2	101.3	91.3	71
30	186	122.2	123.4	115.1	94.4	91.4	80.5	87.6	116.8	98.6	102.6	130.8	136.3	104.7	87.8	105.6	95.1	71
40	192	128.5	129.7	121.6	99.9	96.3	83.5	93.0	123.2	104.1	108.7	137.3	142.8	111.7	94.8	112.8	101.3	72
50	196	133.2	134.5	126.2	104.1	100.0	85.8	97.4	127.9	108.1	113.5	142.1	147.9	117.3	100.7	118.3	106.2	72
60	200	137.0	138.2	129.9	107.3	103.0	87.6	101.1	131.6	111.3	117.2	146.0	151.9	121.7	105.8	122.5	110.3	72

END TEST - COLLECTOR TEMP RISING TOO RAPIDLY

* TC 10 ON TOP OF TUBE ASSY DIRECTLY OVER COLLECTOR

** Average of four sensors

TABLE 8

CONFIGURATION #8 — 1 ea 5mil Indium gasket extending over entire plug, 2 gold screws @ each foot + RTV

FRIDAY 5 AUG 77

TIME MIN.	TEMP COLLECTOR	TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10*	TC11	TC12	TC13	TC14	TC15	TC16	TCMEAN**
0	71	71.7	71.7	71.7	72.1	71.7	72.1	71.7	72.1	72.1	71.7	71.2	71.7	70.4	71.7	70.8	72.1	72.3
10	157	94.2	95.8	93.7	78.3	76.5	73.9	74.3	97.4	80.9	82.3	103.3	107.1	81.8	74.3	82.3	77.4	71.6
20	171	108.4	108.8	108.4	88.0	85.8	77.9	80.9	111.7	92.9	93.3	117.6	122.2	94.2	81.4	95.8	87.6	71.9
30	180	117.2	117.2	117.2	95.8	92.0	81.8	87.6	120.1	100.0	101.2	126.4	131.0	103.3	88.4	104.2	96.2	72.2
40	186	123.0	123.6	123.0	100.4	97.0	84.0	92.9	126.4	105.4	107.1	133.1	137.7	110.5	94.9	111.3	101.6	72.2
50	190	128.1	128.5	128.1	104.6	100.8	86.7	97.9	131.4	109.2	111.3	137.7	142.8	115.5	101.6	116.3	106.7	73.2
60	194	131.4	131.7	132.3	107.1	103.7	88.4	101.6	134.8	112.1	115.1	141.5	147.0	119.7	106.3	120.5	110.5	73.5
70	197	134.8	135.6	135.2	110.0	105.4	89.3	103.7	138.6	115.1	117.6	144.5	150.3	123.0	110.0	123.5	113.8	73.8
80	199	136.9	137.7	136.9	111.7	107.5	91.1	106.3	140.7	116.7	119.7	147.0	152.4	125.6	115.8	126.8	116.3	75.0
90	201	139.0	139.8	139.0	113.4	109.2	92.4	108.8	142.4	118.8	122.2	149.1	154.2	128.5	116.7	128.5	118.8	75.2
100	203	140.7	141.5	141.1	114.7	110.9	92.9	110.9	144.0	119.7	123.0	150.3	155.7	130.2	118.8	130.6	120.9	76.0
110	204	142.4	142.4	141.9	116.3	111.7	93.7	112.1	145.3	120.5	125.1	152.0	156.9	132.3	121.8	132.7	122.6	76.5
120	205	143.2	143.6	143.2	117.2	112.6	94.2	113.4	146.2	121.8	126.4	152.6	158.1	133.1	123.5	134.0	123.9	76.7
130	206	144.5	144.9	144.0	117.6	113.4	95.8	115.1	147.8	122.6	126.8	153.4	159.3	134.4	124.7	135.2	125.1	77.9
140	207	145.3	146.1	145.3	118.4	114.2	95.8	115.9	148.7	123.5	128.1	155.0	160.5	135.6	126.8	135.6	126.4	78.1
150	208	145.7	147.0	145.7	119.3	115.1	96.6	116.7	149.9	124.3	128.9	155.0	160.5	136.9	127.7	136.9	127.7	78.3
160	208	147.0	147.8	146.6	120.1	115.5	97.0	117.6	149.9	124.7	129.3	155.7	161.7	137.7	128.9	138.2	128.5	79.2
170	209	147.4	148.2	147.0	120.9	116.3	97.0	118.8	151.2	125.6	130.2	156.5	162.1	139.4	130.2	138.2	129.3	79.4
180	210	147.8	148.7	147.8	120.9	117.2	98.3	119.3	151.2	126.4	131.0	157.3	162.5	139.4	131.0	139.4	130.2	80.0

* TC 10 ON TOP OF TUBE ASSY DIRECTLY OVER COLLECTOR

** Average of two temp sensors

APPENDIX D-4

IOC-DSCS-D4-035, 777 TWT BASEPLATE S/C INSTALLATION LOADS TEST, J. JUDKINS, 28 JULY 1977

TRW
DEFENSE AND SPACE SYSTEMS GROUP
ONE SPACE PARK • REDONDO BEACH • CALIFORNIA 90278

H. N. Luhrs

AUG 1 1 1977

DSCS-D4-035

INTEROFFICE CORRESPONDENCE

7335.2-192

TO: Jules Streisand CC: Distribution DATE: 28 July 1977

SUBJECT: 777 TWT Baseplate S/C Installation Loads Test

FROM: Jay Judkins

BLDG	MAIL STA.	EXT.
R6	2156	61133

INTRODUCTION

This memorandum provides documentation for a TWT baseplate S/C installation load test conducted through the period of July 7 to July 13, 1977, in Building M2.

The purpose of the test was to determine the loads resulting in the TWT baseplate due to S/C installation forces. The test specimen and the S/C panel were structurally identical to flight hardware with the exception that the TWT collector was not potted.

CONCLUSION

The TWT baseplate sustained a deformation of 540 micro-inches per inch and 475 micro-inches per inch along the collector mounting "shovel" edges, parallel to the tubes longitudinal axes. This could be attributed to yielding of the collector/baseplate solder interface, or permanent deformation of the plate. The highest level of stresses occur after complete installation on the S/C and did not change appreciably with time (after retorquing).

A very idealized and highly simplified model (calculations attached) indicates that yielding of the TWT baseplate could occur. The calculated stress was 38,880 PSI which translates to a margin of safety of - .074 on yield. The maximum shear and tensile stresses in the potting compound are .5 and 35.4 PSI respectively.

It should be stressed that these results are highly approximate, more exact solutions would require a finite element approach.

A complete synopsis of the strain gage and analytical results can be found in Tables #1 and #2. Figure #1 provides strain gage location information.

DISCUSSION

The six strain gages were mounted to the TWT baseplate as shown in Figure #1. They were monitored at various stages of TWT assembly levels, the results are presented in Table #2. The levels were recorded with the TWTA mounted on a S/C panel immediately after assembly then again after 24 hours, 96 hours, and

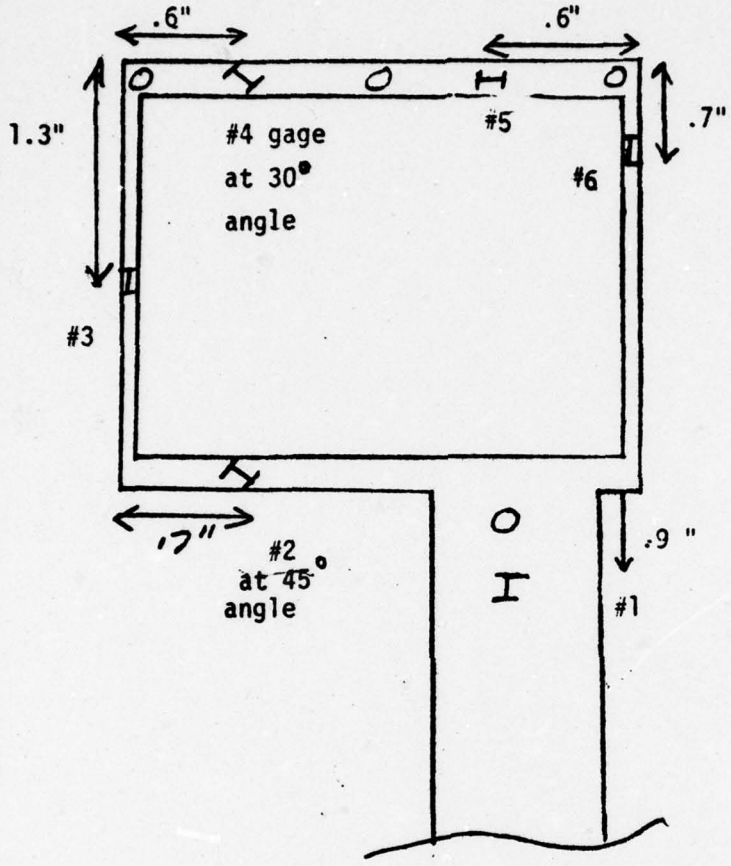
120 hours at which time stablization had occurred. The maximum level recorded was at gage location #6 (approximately 20,000 PSI). Gages #3 and #6 both recorded a strain after disassembly of 475 and 540 micro-inches per inch respectively. This corresponded to an approximate base deformation of 2 to 3 mills. When the TWTA is attached to the S/C panel, the portion of the TWT baseplate that serves as a mounting area for the collector is deflected over an Indium "staircase" (used for thermal reasons). There are three fasteners on the bottom "step" side. The collector and baseplate form a beam which is approximately twice as stiff as the plate at the collector mounting edges. On the edge with one fastener the deflection, due to mounting, is absorbed at the point of maximum stiffness change. An idealized model of this event indicates that minor yielding will result in the plate. The resulting stresses in the potting compound are low.

Jay Judkins

JJ:nc

ATTACHMENT I
ANALYTICAL SYNOPSIS
TABLE I

Plate tensile stress portion under collector	8310 psi
Allowable yield	36,000 psi
Margin of Safety	
Plate tensile stress at collector edge with one S/C fastener	38,880 psi
Allowable yield	36,000 psi
Margin of safety	-.074
Shear stress in potting	.5 psi
Tensile stress in potting	.56 psi to 35.4 psi



I ⇒ Indicates Sensor Directory

Sensor Locations

Figure #1

	Configuration #1 Mounted on Transit Plate Inside the TWTA Case Without the Collector Cover		Configuration #2 Added Collector Cover		Configuration #3 Removed Transit Plate		Co Mo Pl Fo wh Pl
Gage #	Strain	Stress	Strain	Stress	Strain	Stress	St
1	207	2,070	200	2,000	176	1,760	15
2	-30	-300	-30	-300	0	0	-3
3	-20	-200	-20	-200	-20	-200	-1
4	465	4,650	465	4,650	440	4,400	5
5	388	3,880	387	3,870	396	3,960	50
6	125	1,250	148	1,480	160	1,600	10

Notes:

(1) Readings in micro-inches per inch & PSI

(2) ( ) ( ) readings indicate before and after torquing

Strain Gage Data

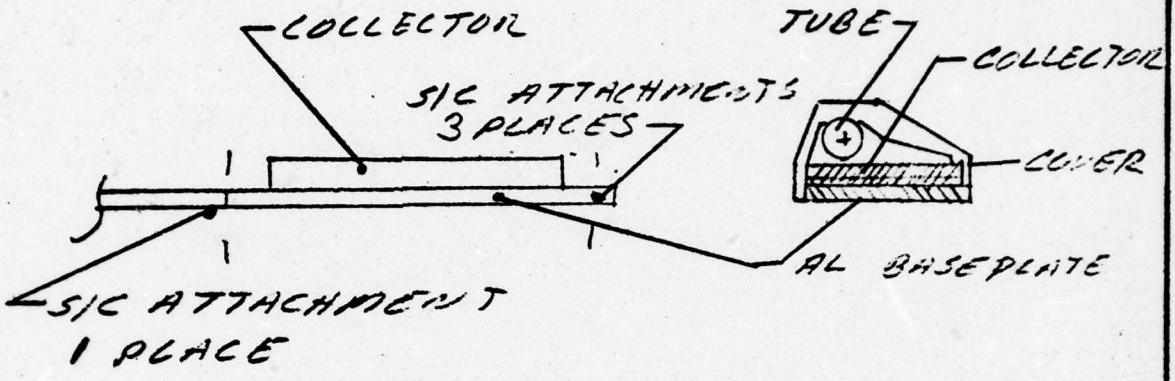
guration #4 ted TWTA to S/C form Without the S/C Fasteners h Attach to the form Heatsink			Configuration #5 Installed the four S/C Heat Sink Fasteners					
	After 10 Minutes		After 24 Hours		After 96 Hours		After 120 Hou	
in Stress	Strain	Stress	Strain	Stress	Strain	Stress	Strain	Str
1	-210	-2,100	(-138) (-185)	(-1380) (-1850)	(-185) (-185)	(-1850) (-1850)	(-185) (-185)	(-1 (-1
-300	255	2,550	(630) (690)	(6300) (6390)	(660) (660)	(6600) (6600)	(630) (630)	(63 (63
-150	530	5,300	(265) (260)	(2650) (2600)	(460) (460)	(4600 (4600)	(510) (520)	(51 (52
50	120	1,200	(660) (945)	(6600) (9450)	(990) (985)	(8900) (8950)	(970) (985)	(97 (98
500	430	4,300	(780) (940)	(7800) (9400)	(895) (960)	(8950) (9600)	(965) (965)	(96 (96
100	2115	21,150	(1520) (1645)	(15,200) (16,450)	(1790) (1850)	(17,900) (18,500)	(1930) (1935)	(19 (19

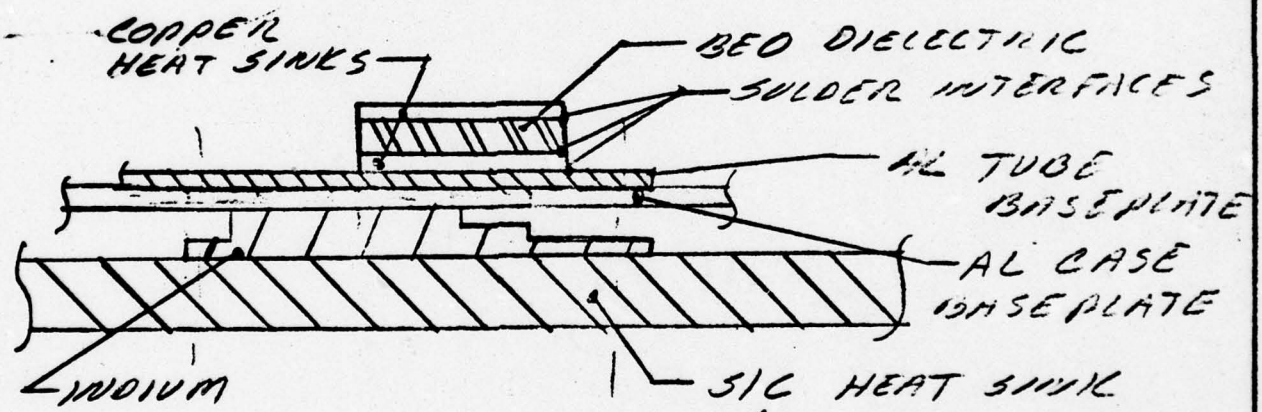
TABLE 2

	Configuration #6 Removed TWT from TWTA, then removed Collector Cover	
s	Strain	Stress
0) 0)	0	0
))	330	3300
))	475	4750
))	-35	-350
))	0	0
00) 50)	540	5,400

TRW SYSTEMS GROUP		PREPARED BY: N. J. J.	ATTACHMENT	PAGE
PROJECT 777	SUBJECT TWT	DATE 7/77	II	1 OF 9

STRUCTURAL CONFIGURATION





SCHEMATICS

SYSTEMS 1400 REV. 2-66

MATERIAL PROPERTIES

E = YOUNGS MODULUS

F_{TY} = ALLOWABLE YIELD STRESS

ALUMINUM 6061-T6

$E = 11 \times 10^6$ PSI

$F_{TY} = 36,000$ PSI

REF: MIL-HNBK II

COPPER -HARD

$E = 17 \times 10^6$ PSI

$F_{TY} =$

REF: MIL-HNBK -D

BEO

$E = 47 \times 10^6$ PSI

$F_{TY} = 33,000$ PSI

REF: ALSIMAG CERAMICS CHART # 711

$E \simeq 3,000$ PSI

T_y = SHEAR ALLOWABLE =

$\bar{T}_{TY} =$

REF: HUGHES

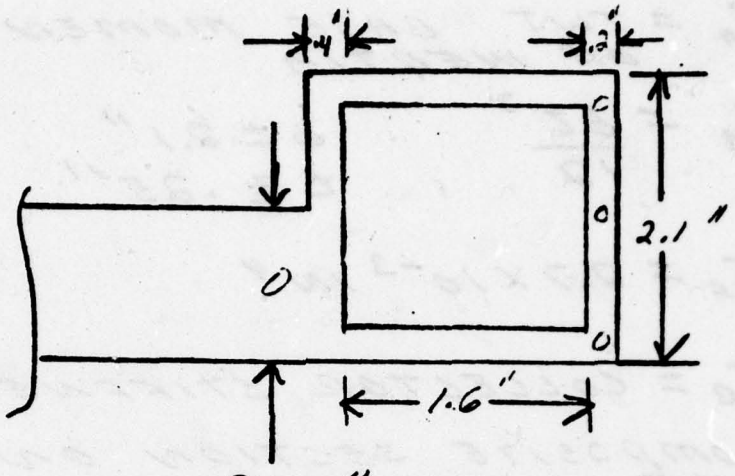
SYSTEMS 1490 REV. 2-68

TRW SYSTEMS GROUP		PREPARED BY: N. J. J.	ATTACHMENT	PAGE 3 OF 9
PROJECT 777	SUBJECT TWTA	DATE 7/77	II	

ANALYSIS

- CANTILEVER ACTION BETWEEN FASTENERS
- "FLAT" ALUMINUM CASE & TWT BASEPLATE
- POTTING DOES NOT HAVE STIFFNESS ($E \approx 10^5$ PSI COMPARED TO 10^7 PSI FOR ALUMINUM)
- COLLECTOR ACTS AS A COMPOSITE BEAM)
- COLLECTOR & TWTA BASEPLATE ACT INDEPENDENTLY)
- INDIUM DOES NOT COMPRESS.

SYSTEMS 1489 REV. 4-68



≥ 1.2" (REACTION LENGTH)

NOTES:

(1) THE BEARING REACTION WIDTH WILL BE ≥ 1.2" ON THE ONE FASTENER SIDE

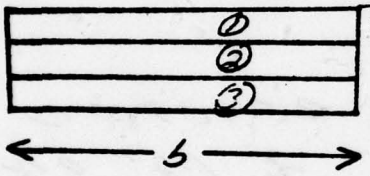
(2) THE INDIUM SUPPORTS ≥ 1.0" OF THE PLATE NEARST THE ONE FASTENER SIDE

I_A = TWT BASE MOMENT OF INERTIA

$$I_A = \frac{bt^3}{12} \qquad b = 2.1'' \quad t = .25''$$

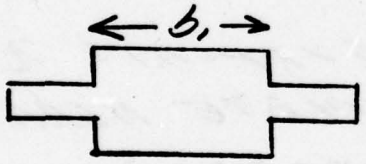
$$I_A = 2.7 \times 10^{-3} \text{ IN}^4$$

I_B = COLLECTOR STIFFNESS COMPOSITE SECTION ON A UNIT WIDTH BASIS



Cu $t_1 = .06''$
BEO $t_2 = .188''$
Cu $t_3 = .06$

$$\frac{E_1}{E_2} = \frac{17}{47} = .36 = b_1$$



EQUIVACENT BEO SECTION

$$I_{Bu} = \frac{b_1(t_1+t_2+t_3)^3}{12} + \frac{t_2^3(b-b_1)}{12}$$

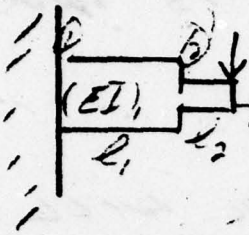
$$I_B = \left[\left(\frac{.36}{12}\right)(.25)^3 + (.17)^3\frac{(.64)}{12}\right] 2.1$$

$$I_B = 1.73 \times 10^{-3} \text{ in}^4$$

I_L = BASE STIFFNESS AT ONE FASTENER END $\frac{2}{2} I_A/2$

SYSTEMS 1489 REV. 2-68

CONSIDER THIS CONFIGURATION



ONE FASTENER END

$\ell_1 = .5$" (EFFECTIVE)

$\ell_2 = .7$"

$\ell = \ell_1 + \ell_2 = 1.2$"

$(EI)_1 = I_A E_a + I_b E_b$

$(EI)_1 = 27{,}000 + 81{,}310$

$(EI)_1 = 108{,}310 \ \text{lbs-in}^2$

$(EI)_2 = \left(\frac{I_A}{2}\right) E_a = 13{,}500 \ \text{lbs-in}^2$

δ = TOTAL DEFLECTION

$\delta = \delta_1 + \delta_2$

$$\delta = \frac{P\ell_1^3}{3(EI)_1} + \frac{P\ell_2^3}{3(EI)_2}$$

$\delta = P\left[.3 \times 10^{-6} + 4.2 \times 10^{-6}\right]$

$\delta = (P)(4.5 \times 10^{-5})$ in

LET THE $\delta \approx .01"$, EACH LAYER OF MOLY IS .005" THICK.

$P = 22316S$

THE FASTENER WILL ONLY APPLY APPROXIMATELY 6016S

$\therefore$,

$M_{1P} = PR = 720$ IN-16S

THIS IS MAXIMUM MOMENT, THE MAXIMUM MOMENT IN THE PLATE WILL BE LESS, THE STRESS IS

$$\sigma_{1P} = \left[\frac{M_m (EI)_2}{(EI)_1} \right] \left(\frac{c}{I} \right)$$

$\sigma_{1P} = 8,310$ PSI

THIS LESS THAN THE STRAIN GAGE #6 READ OUT. NOTE THAT IT'S READ OUT WILL BE HIGHER.

$$M.S. = \frac{36,000}{8,310} - 1 = \text{HIGH}$$

SYSTEMS 1409 REV. 2-68

DUE TO THE ABOVE CHANGE IN STIFFNESS, THE $\frac{1}{2}$ LENGTH WILL ABSORB MOST OF THE DEFLECTION.

$$\sigma_2 = \frac{PL_2 C}{I}$$

$$I = I_A/2$$

$$\sigma_2 = \frac{600 \times .7 \times .125}{1.35 \times 10^{-3}}$$

$$\sigma_2 = 38,880 \text{ psi}$$

$$M.S. = \frac{36,000}{38,880} - 1 = -.074$$

STRESS IN POTTING

CONSIDER ONLY THE PORTION ATTACHED TO $\frac{1}{3}$ THE COLLECTOR FACE & ASSUME IT MUST ABSORB ALL OF THE DEFLECTION.

$$\delta = \frac{P_0 L_2^3}{3EI} = 4.2 \times 10^{-6} P$$

$$P_0 = \frac{3EI \times 4.2 \times 10^{-6}}{L_2^3} \times P = .022EI$$

$$E = 3000 \text{ psi}$$

$$I = \frac{bt^3}{12} = 1.1 \times \frac{(.25)^3}{12} = 1.4 \times 10^{-3} \text{ in}^4$$

$$P_0 = .095\ 165$$

τ = SHEAR STRESS (MAXIMUM)

$$\tau = 1.5\frac{V}{A}$$

$$A = 1.1 \times .25 = .275 \text{ in}^2$$

$$V = P_0$$

$$\tau = .50 \text{ PSI}$$

σ = TENSILE STRESS (MAX)

$$\sigma = \frac{MC}{I}$$

$$M = P_0 L_2 = .095 \times .7 = 6.3 \times 10^{-2} \text{ in-lbs}$$

$$\sigma = \frac{6.3 \times 10^{-2} \times .125}{1.4 \times 10^{-3}} \times 10$$

$$\sigma = 5.6 \text{ PSI}$$

ANOTHER METHOD FOR σ WOULD BE TO CONSIDER THE POTTING & PLATE AS A COMPOSITE BEAM (CONCENTRATIVE)

$$\sigma = \frac{MCE_p}{I_A E_a} = \frac{600 \times .7 \times .38 \times 3 \times 10^7}{1.35 \times 10^{-3} \times 10 \times 10^6}$$

$$\sigma = 35.4 \text{ PSI}$$

APPENDIX E

DSCS TWTA REVIEW GROUP

APPENDIX E-1

DEFENSE SATELLITE COMMUNICATIONS SYSTEM PHASE II (DSCS II)

DEFENSE SATELLITE COMMUNICATIONS SYSTEM PHASE II

(DSCS II)

DSCS TWTA REVIEW GROUP

OBJECTIVE: MAKE RECOMMENDATIONS FOR INCREASING CONFIDENCE IN TWTA PERFORMANCE

- o NEAR TERM (NEXT LAUNCH)
- o LONG TERM

METHOD:

- o REVIEW AVAILABLE DATA PERTAINING TO FAILURES (DSCS & OTHER)
  - o IN-PLANT TESTS
  - o ORBITAL
- o REVIEW DSCS GROUND TEST PROGRAM, COMPARE WITH OTHERS
  - o FOCUS ON ENVIRONMENTAL TESTING
- o ANALYZE DESIGN OF 20 WATT HIGH LEVEL TWTA
- o REVIEW PRIOR TWTA STUDIES
- o CONDUCT AN IN-DEPTH FAILURE MODES AND EFFECTS ANALYSES

DSCS TWTA REVIEW GROUP

CHAIRMAN: COL BOB D. BROWNING (SK)

MEMBERS:

DCA	LL
SAMSO	JPL
SAFSP	COMSAT CORP.
AFAL	TRW
AFPRO	HUGHES
AEROSPACE	

- o FIRST MEETING WILL BE 1 JUN 77
- o FINDINGS WILL BE DISTRIBUTED TO GOVERNMENT AGENCIES AND INDUSTRY AS APPROPRIATE

DSCS MISSION

- TO PROVIDE SHF (7/8 GHz) SATELLITE COMMUNICATIONS FOR SECURE VOICE AND HIGH DATA RATE TRANSMISSIONS IN SUPPORT OF CRITICAL GLOBALLY DISTRIBUTED DOD AND OTHER SPECIAL USERS:
  - WWMCCS
  - DEFENSE COMMUNICATIONS SYSTEM (DCS)
  - GROUND MOBILE FORCES (GMF)
  - NATIONAL COMMAND AUTHORITY (NCA)
  - WHITE HOUSE COMMUNICATIONS AGENCY (WHCA)
  - NATIONAL SECURITY AGENCY (NSA)
  - DIPLOMATIC TELECOMMUNICATIONS SERVICE (DTS)

SUCCESSFUL LAUNCH

SATELLITES ARRIVE CAPE CANAVERAL	8 APR 77	
MATE WITH LAUNCH VEHICLE	22 APR 77	
LAUNCH	12 MAY 77	1427Z
ORBITAL INSERTION 9437, 93°W	12 MAY 77	2055Z
ORBITAL INSERTION 9438, 93°W	12 MAY 77	2107Z

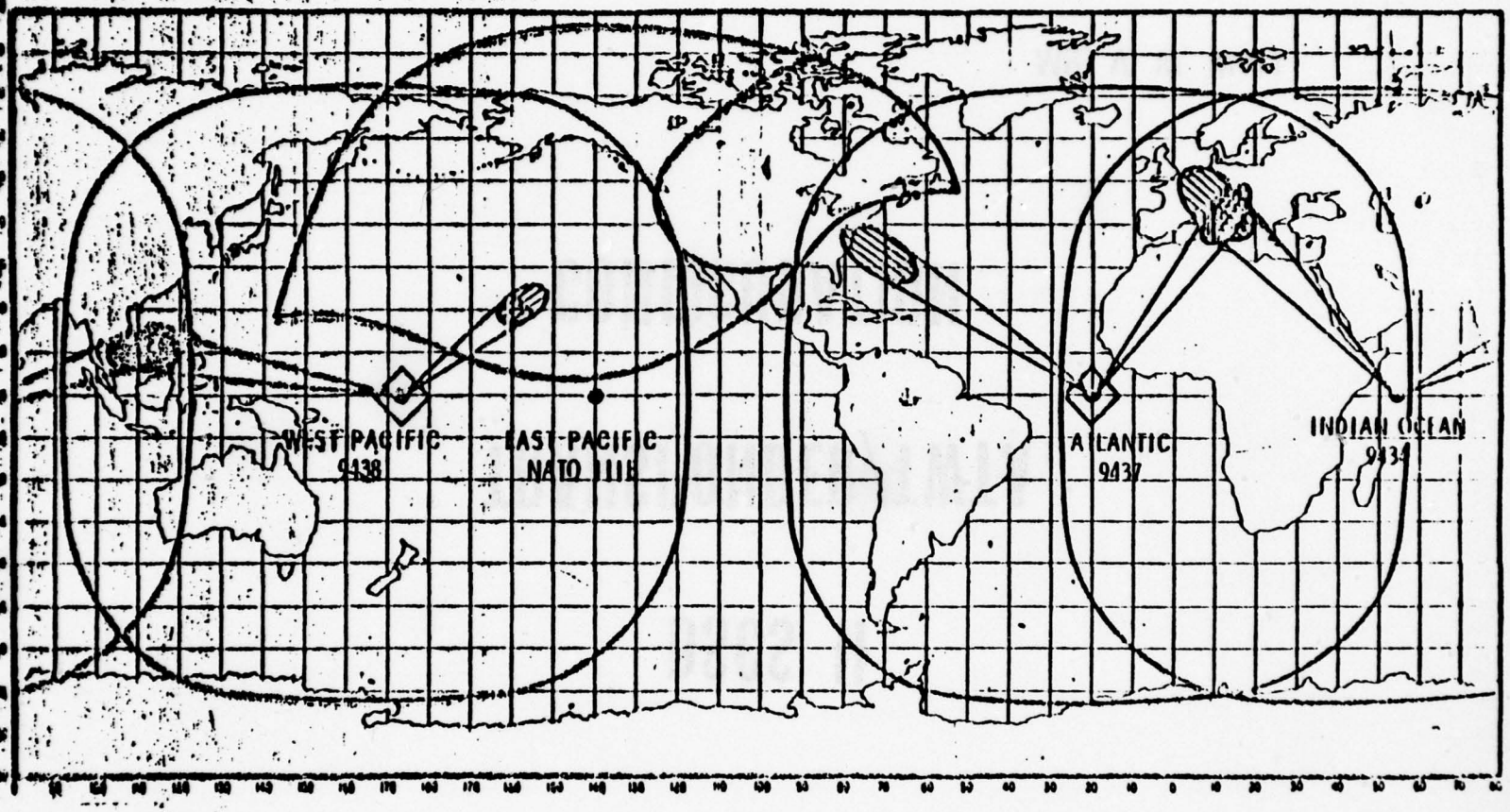
ORBITAL OPERATIONS - SATELLITE 9437

12-15 MAY 77	TT&C AND CONTROLS CHECK-OUT
13 MAY 77	ATTITUDE CORRECTION - 2.5^{0} TO 0.4^{0}
21 MAY 77	ATTITUDE CORRECTION - 0.4^{0} TO 0.04^{0}
24 MAY 77	COMMUNICATIONS TESTING SUCCESSFULLY COMPLETED
25 MAY 77	DELTA V, EASTWARD DRIFT
8 JUN 77	ARRIVE ON OPERATIONAL STATION, 12^{0}W (ATLANTIC)

ORBITAL OPERATIONS - SATELLITE 9438

12-15 MAY 77	TT&C AND CONTROLS CHECK-OUT
14 MAY 77	ATTITUDE CORRECTION - 8.4^{0} TO 0.45^{0}
19 MAY 77	ATTITUDE CORRECTION - 0.45^{0} TO 0.02^{0}
19 MAY 77	DELTA V, POSITION SATELLITE 106^{0} W
20 MAY 77	HIGH LEVEL NARROW COVERAGE TUBE FAILURE
26 MAY 77	COMMUNICATIONS TESTING STARTS
17 JUN 77	ARRIVE ON OPERATIONAL STATION, 175^{0} E (WESTPAC, REPLACES 9434)

DSCS Planned Satellite Deployment/Coverage



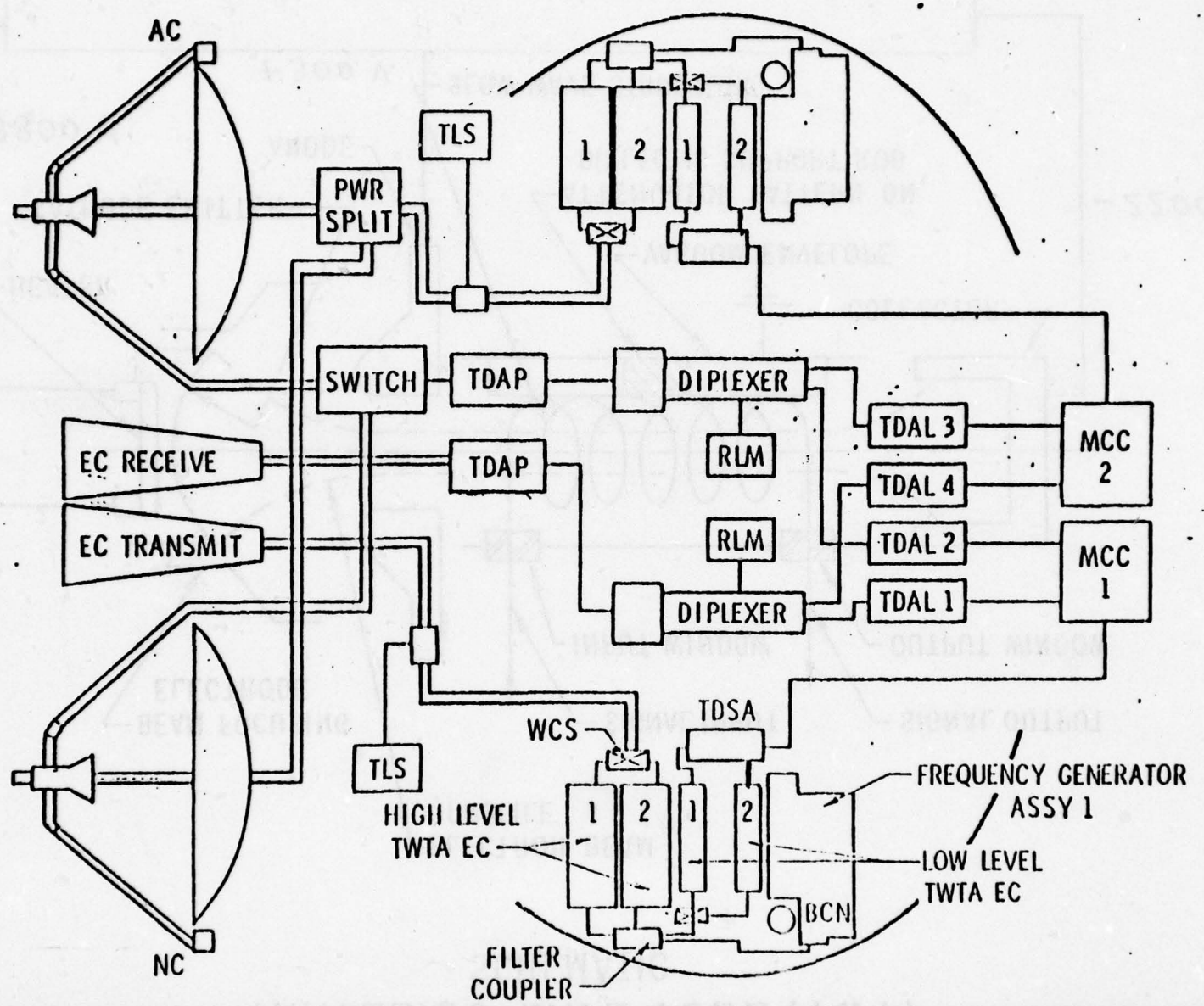
DSCS II

TRANSPONDER/TWTA

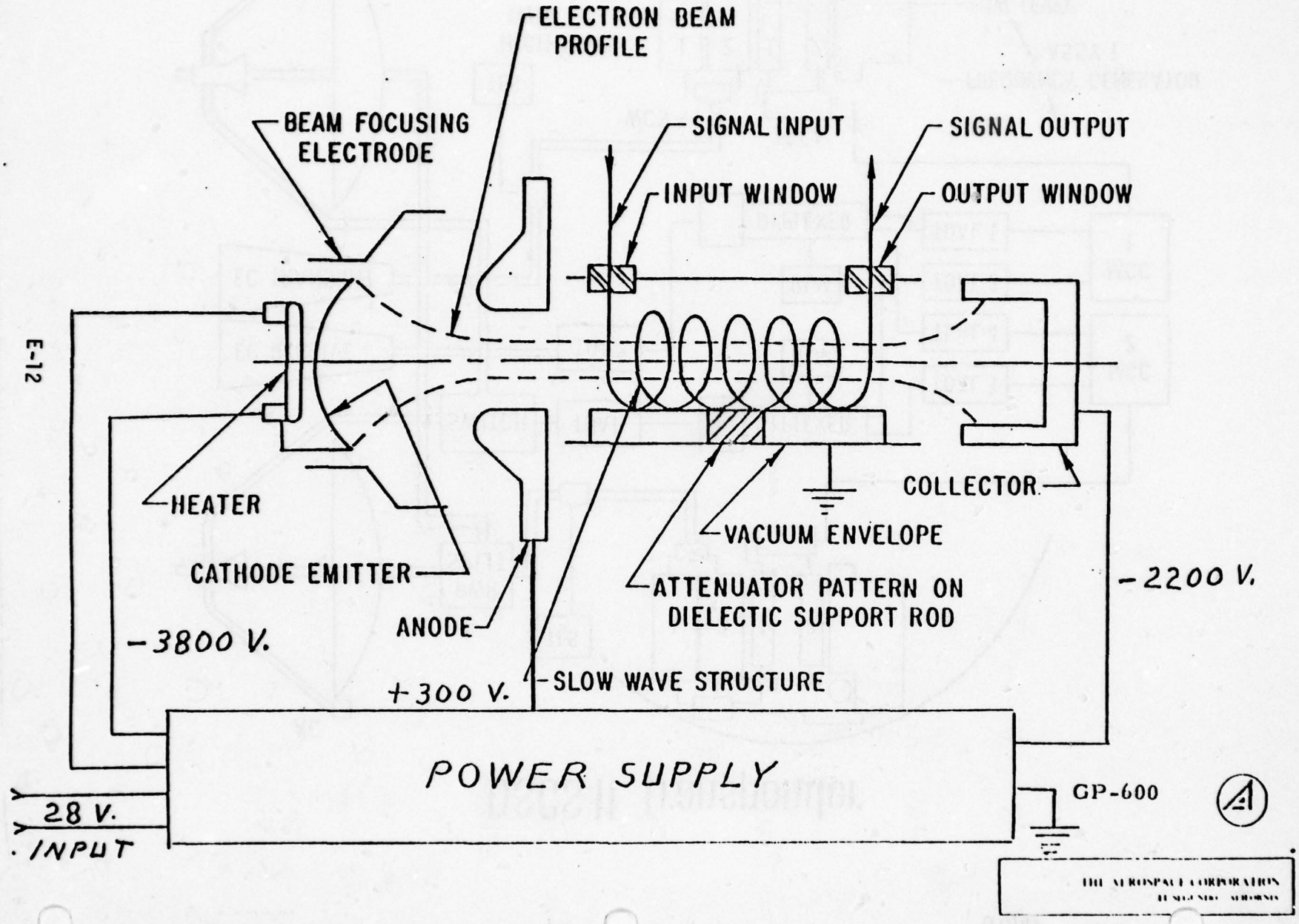
CONFIGURATION

MR. V. W. WALL

DSCS II Transponder

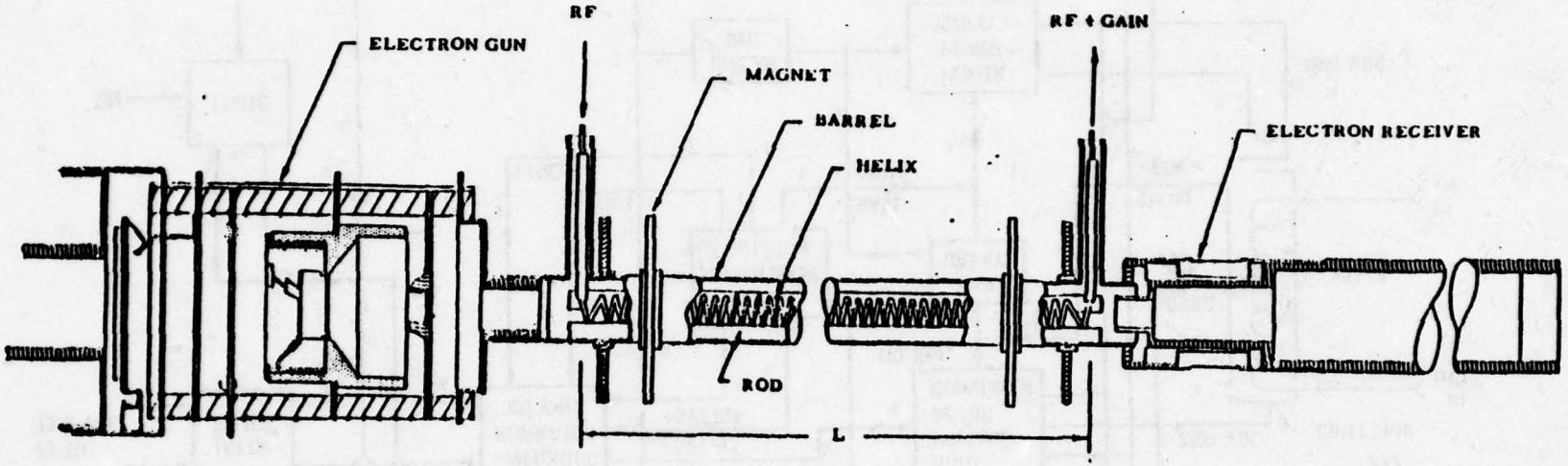


TRAVELING WAVE TUBE (TWT)
SCHEMATIC



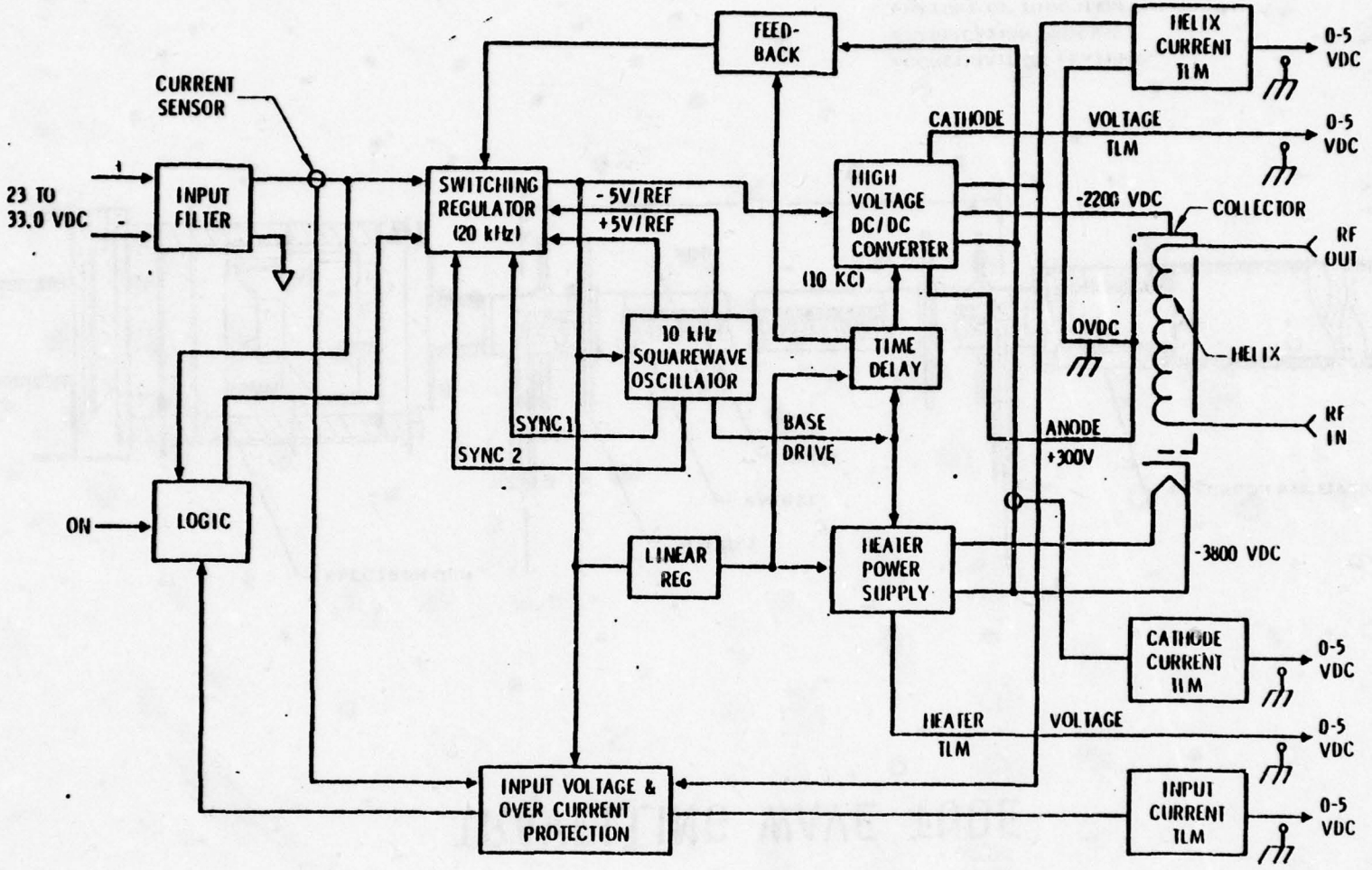
THE AEROSPACE CORPORATION

TRAVELLING WAVE TUBE



- CONSTRUCTION FEATURES
- FABRICATION PROCESS
- NATURE OF TUBE MALFUNCTION
- CONTRACTOR'S INVESTIGATION

High Level TWTA Block Diagram



TWTA DEVELOPMENT PROBLEMS

TWT

- CATHODE POISONING
- CATHODE LIFTING
- HELIX TUMBLING
- ATTENUATOR DEGRADATION
- ADEQUATE TWT YIELD DURING MANUFACTURING

POWER CONVERTER

- HIGH VOLTAGE CORONA
- PACKAGING WITHIN WEIGHT AND VOLUME CONSTRAINTS
- PARTS FAILURE

TWTA GROUND TESTS

HL TWT, A UNIT QUALIFICATION TEST

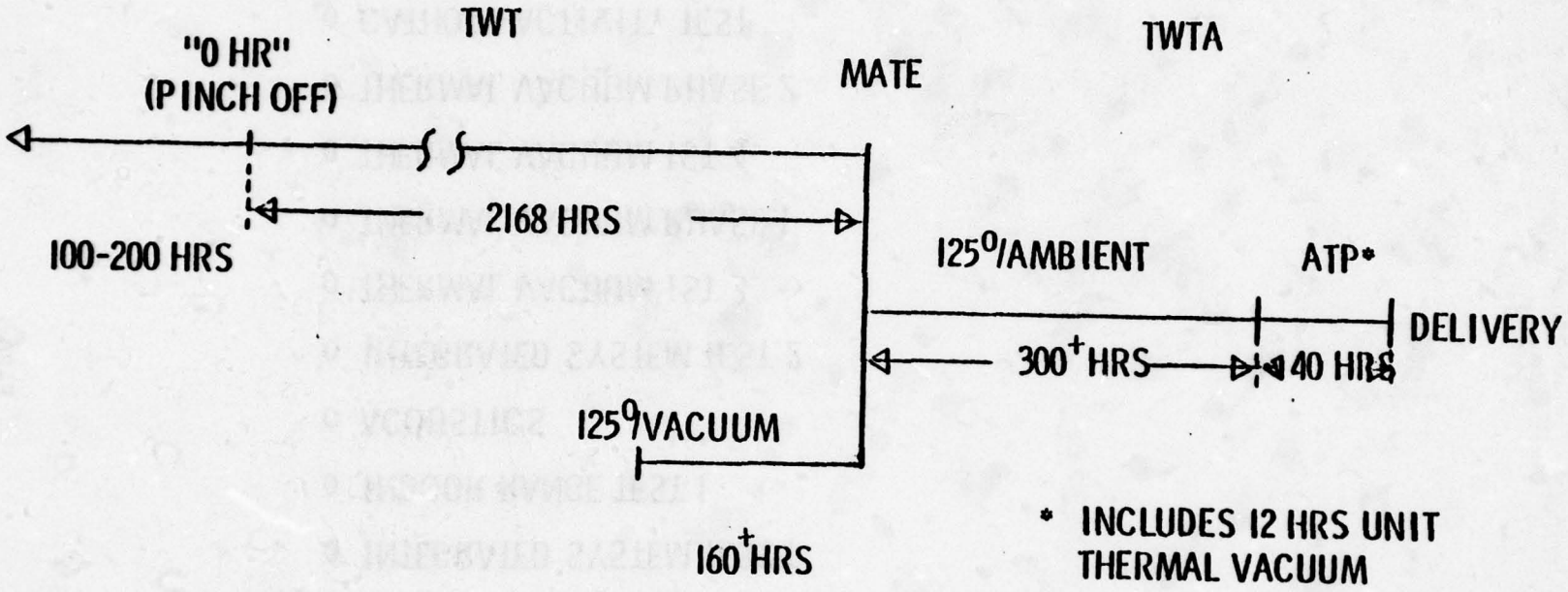
TEST										
	EMC	FUNCTIONAL	THERMAL VACUUM	FUNCTIONAL	TEMP STORAGE (N.O.)	FUNCTIONAL	ACCELERATION (N.O.)	FUNCTIONAL	VIBRATION	PERFORMANCE MEASUREMENTS
		X	X	X		X		X	X	POWER OUTPUT
		X	X	X		X		X	X	GAIN FLATNESS
		X	X	X		X		X		GAIN SLOPE
		X	X					X		SPURIOUS OUTPUT
		X	X	X		X		X		SATURATED GAIN
		X	X	X		X		X		SMALL SIGNAL GAIN
			X							GAIN STABILITY
		X	X	X		X		X		TIME DELAY
		X	X	X		X		X		PHASE CHANGE VS. INPUT POWER
		X	X	X		X		X		INTERMODULATION DISTORTION
		X	X	X		X		X	X	TWTA SUPPLY CHARACTERISTICS
	X									TOR -1001(2307)-4

HL TWTA UNIT ACCEPTANCE TEST

MEASUREMENTS[3]	TEST				
	FUNCTIONAL	VIBRATION[1]	FUNCTIONAL	THERMAL VACUUM[2]	FUNCTIONAL
POWER OUTPUT	X	X		X	X
GAIN	X	X	X	X	X
GAIN FLATNESS	X	X	X	X	X
GAIN SLOPE	X		X	X	X
INTERMODULATION DISTORTION	X			X	X
SPURIOUS OUTPUT	X			X	X
TWTA SUPPLY CHARACTERISTICS	X			X	X
STABILITY	X	X	X	X	X
PHASE CHANGE VS. INPUT POWER	X				X
VSWR	X				X
CATHODE ACTIVITY					X
TIME DELAY	X			X	
INSERTION LOSS	X				X
GAIN STABILITY				X	

NOTES: 1. RANDOM 20-20,000 Hz, 9.8G RMS
2. 60° TO 159° F, 6 HOUR SOAK
3. PRE-ACCEPTANCE TESTING
TWT - 2168 HOURS AMBIENT BURN-IN
EPC - 168 HOURS THERMAL VACUUM
TWTA - 332 HOURS AT 125° F

TWTA BURN-IN



PLUS ABOUT 300 HRS AT SATELLITE LEVEL OF WHICH ABOUT 36 ARE IN THERMAL VACUUM

SATELLITE LEVEL TESTING

- o COMM SUBSYSTEM INTEGRATION
- o COMM PERFORMANCE TEST I
- o COMM SUBSYSTEM TEMPERATURE TEST
- o INTEGRATED SYSTEM TEST I
- o INDOOR RANGE TEST I
- o ACOUSTICS
- o INTEGRATED SYSTEM TEST 2
- o THERMAL VACUUM IST 3
- o THERMAL VACUUM PHASE I
- o THERMAL VACUUM IST 4
- o THERMAL VACUUM PHASE 2
- o CATHODE ACTIVITY TEST
- o COMM PERFORMANCE TEST 2
- o INDOOR RANGE TEST 2
- o HAT INTEGRATED SYSTEM TEST (TRW)
- o HAT INTEGRATED SYSTEM TEST (ETR)

SPECIFICATIONS

MAX DC INPUT	103 WATTS
RF OUTPUT	20 WATTS
SATURATED GAIN	45-48 dB
NOISE FIGURE	33 dB
USEFUL LIFE	62,000 HRS
OPERATING BANDWIDTH	K - 7250-7450 MHz L - 7490-7750 MHz
TELEMETRY DATA	TWT HEATER VOLTAGE TWT CATHODE CURRENT TWT HELIX VOLTAGE TWT HELIX CURRENT TWTA INPUT CURRENT

PROBLEMS

- TRAVELING WAVE TUBE AMPLIFIER (TWTA) FAILURES
  - SATELLITE 9438, 20 MAY 77
  - SATELLITE 9434, 23 MAY 77
    (LAUNCHED 13 DEC 73/NOW OPERATING ON REDUNDANT TWTA)

SATELLITE 9438

- o NARROW COVERAGE TWTA TURNED OFF 20 MAY 77/0805Z
  - o NO SCF STATIONS ACTIVE
  - o PT. PILLAR RECORDED DATA
- o RECOVERY ATTEMPTS UNSUCCESSFUL TO DATE (15 attempts)
  - o SINGLE AND MULTIPLE COMMANDS
  - o TWTA ALWAYS TIMES OUT WITHOUT TURNING ON
- o FAILURE MODE
  - o NO TRANSIENTS BEFORE OR AFTER
  - o SHARP TURN OFF
  - o NO HIGH CURRENT DRAW

SATELLITE 9434

- o NARROW COVERAGE TWTA TURNED OFF 23 MAY 77/0808Z
  - o NO SCF STATIONS ACTIVE
  - o SCF NOTIFIED AND ACTIVE ON 9434 WITHIN 11 MINUTES
- o RECOVERY ATTEMPTS UNSUCCESSFUL
  - o NO INPUT CURRENT
  - o TEMPERATURES FALLING
- o REDUNDANT TWTA SELECTED
  - o COMMUNICATIONS RESTORED AT 0930Z
  - o TEMPERATURES STABLE
  - o COMMUNICATIONS PERFORMANCE NORMAL

OTHER TWTA PROBLEMS

S/C 9431 HLTWTA FAILURE

(S/N 14-5, 21 DEC 72)

- FAILURE SEQUENCE
  - TWTA, OPERATING NORMALLY, TURNED OFF WITHOUT COMMAND
  - SWITCH TO REDUNDANT TWTA
  - ATTEMPT TO RESTART TWTA ON 18 APRIL 1973 FAILED
    - NORMAL TURN ON DELAY
    - SHUTDOWN OCCURRED WITH HV TURN ON
- ANALYSIS/CONCLUSIONS
  - LIKELY CAUSES WERE FAILURE OF HV SECTION OF POWER SUPPLY
  - TWT FAILURE

S/C 9434 HLTWTA FAILURE

(S/N 14-10, 17 AUG 74)

- o FAILURE SEQUENCE
  - o TWTA OFF
  - o ATTEMPT TO TURN ON FAILED
    - o NORMAL TURN ON DELAY
    - o TWTA TURNED OFF WITHIN 2 SECONDS OF HV TURN ON
    - o INPUT CURRENT LOW
- o ANALYSIS/CONCLUSIONS
  - o MOST LIKELY FAILURE WAS COMPONENT FAILURE IN REGULATOR OR HV SECTION
  - o PROBABLE CAUSE OF TURN OFF HELIX OVERCURRENT TRIP

NATO III-A FAILURE

- o WIDE BAND TWTA TURNED OFF 9 MAR 77/0722Z, 9 MAR 77/1331Z, 23MAR 77/0221Z
  - o NO SCF STATIONS ACTIVE, NORMAL OPERATIONS
  - o OUTAGES REPORTED BY USERS (NATO, DCA, UK)
- o RECOVERY ATTEMPTS
  - o TWTA COMMANDED BACK ON TWICE
  - o AFTER THIRD FAILURE, TWTA TIMED OUT WITHOUT TURNING ON
  - o REDUNDANT UNIT SELECTED, NORMAL OPERATIONS RESTORED
- o FAILURE MODE
  - o REVIEW OF TELEMETRY DATA PRIOR TO AND AFTER EVENT SHOWS NOMINAL PERFORMANCE
  - o NORMAL HEATER VOLTAGE AND INPUT CURRENT

RCA SATCOM TWTA ANOMALIES

SATCOM I

- o LAUNCHED DECEMBER 13, 1975
- o POSITIONED AT 135.8° W
- o ~MONTH AFTER LAUNCH TWTA AUTO TURNOFF
  - o TWTA TURNS OFF WHEN HIGH VOLTAGE ENABLED

SATCOM 2

- o LAUNCHED MARCH 28, 1976
- o POSITIONED AT 118° W
- o TWTA IN TRANSPONDER 22 AUTO TURNOFF
  - o 1-25-77 AT 0318Z
  - o 3-10-77 AT 0230Z
  - o 3-11-77 AT 0415Z
  - o 3-18-77 AT 0240Z
  - o NOW OPERATING NORMALLY
  - o BASED ON GEOS-I DATA, RCA THINKS SUBSTORMS MAY HAVE BEEN CAUSE

ON GOING EFFORTS

ON GOING EFFORTS

- o 40 WATT TWTA
  - o DSCS II AND III JOINT EFFORTS
  - o HUGHES
  - o WATKINS-JOHNSON BACK-UP
- o 10 WATT TWTA
  - o DSCS III EFFORT
  - o WATKINS-JOHNSON
  - o HUGHES BACK-UP
- o SOLID STATE PLANNING

IMMEDIATE PLAN OF ACTION

- o CONTINUE FAILURE INVESTIGATION UNDERTAKEN BY TRW/HUGHES EDD
- o REVIEW ON-GOING TWTA DEVELOPMENT EFFORTS FOR CHANGES
- o CONVENE DSCS TWTA REVIEW GROUP

CURRENT ACTIVITIES

- o DATA GATHERING
  - o TWTA DATA PACKAGES
  - o ORBITAL TEST DATA
  - o REDUCED DATA
  - o DRAWINGS, SPECS, PROCEDURES
- o EXTENDED TWTA TESTING
- o POWER SUPPLY CIRCUITRY REVIEW
- o FAILURE MODES ANALYSIS
- o REVIEW OF ADDITIONAL TESTING
- o DAILY REVIEW MEETING

APPENDIX E-2

DSCS TWTA REVIEW GROUP CONCERNS

TWTA FAILURE MODE

CONCERN:

- COAX CONNECTORS ARE USED WHICH ARE PRONE TO FAILURE.

BACKGROUND:

- RG-141 COAX CABLES ARE USED TO MAKE RF CONNECTIONS TO THE TWT.
- THE COAX CENTER CONDUCTOR IS UTILIZED AS THE MALE CONNECTOR CENTER PIN.
- THE COAX MALE CONNECTOR CENTER CONDUCTOR IS SOFT AND OFTEN PUSHED ASIDE BY THE FEMALE CONNECTOR CENTER PIN.
- THE MISALIGNED OUTER CONDUCTOR EXHIBITS ERRATIC TRANSMISSION AND OFTEN EVENTUALLY SHORT CIRCUITS TO GROUND.
- WHEN THE COAX CONNECTOR PAIR ARE SUCCESSFULLY MATED, THE HARD FEMALE CENTER PIN SCRAPES METAL CHIPS OFF THE SOFT MALE CENTER CONDUCTOR.
- THESE METAL CHIPS PROVIDE A CONDUCTOR PATH TO GROUND.

CONCLUSION:

- MALE RG-141 COAX CABLE CONNECTORS WHICH UTILIZE CENTER CONDUCTORS FOR CENTER PINS ALLOW DEMONSTRATED FAILURE MODES IN THE RF PORTION OF TWTAs AND SHOULD NOT BE USED.

TWTA FAILURE MODE (CONT.)

RECOMMENDATION: 9/10 AND FUTURE

- **REPLACE COAX CONNECTORS INTERNAL TO THE TWTA WITH CONNECTORS WHICH UTILIZE SEPARATE HARDENED CENTER PINS.**

TWTA FAILURE ANALYSIS

CONCERN:

- UNAVAILABLE CONCISE RECORD OF COMPLETED TWTA TESTS

BACKGROUND:

- UNITS GO THROUGH ACCEPTANCE TEST, IST, THERMAL-VACUUM, SHAKE, ETC.
- RECORDS OF TEST RESULTS, DATE, ANOMALIES, REPAIRS AND RETEST ARE KEPT
- THESE RECORDS ARE NOT IN ONE LOCATION.
- A BRIEF AND CONCISE DOCUMENT CERTIFYING WHEN TESTS OR REPAIRS WERE COMPLETED IS NOT AVAILABLE.

CONCLUSION:

- DETERMINING THE CLEAR PAST HISTORY OF TWTAs THAT FAIL TO AID IN FAILURE ANALYSIS AND PREVENTION IS VERY DIFFICULT.
- TIMELY FAILURE ANALYSIS OF TWTAs IS IMPEDED BY LACK OF CONCISE TWTA TEST AND HANDLING RECORD.

RECOMMENDATION:

F 9/10 - DETERMINE AND REVIEW PAST HISTORY OF TWTAs ON F9/F10.

FUTURE - PROVIDE A CONCISE UNIT TEST RECORD FORM FOR EACH TWTA AND REQUIRE THAT IT BE USED TO CERTIFY TEST AND REPAIR HISTORY.

CONCERN: Susceptibility of 1202 HA Power Control Circuits To Vehicle Bus Transients Questionable

BACKGROUND: T/M Data on 24-17 Indicates Erratic C_1 Power Supply Performance Possible Cause

No Test Data On Transient Response of Power Supply

RECOMMENDATION: 9/10 & Future

Run Susceptibility Tests on One Of The Four TWTAs For Conducted Interference

$\pm$ 50 v Transient - 1 v RMS Ripple 30 Hz to 400 MHz

TWTA ON ORBIT TEMPERATURE

CONCERN:

- THE TEMPERATURE OF THE COLLECTOR AREA OF THE TWTA ON THE S/C ON ORBIT MAY EXCEED THE UPPER RATING LEVEL.

BACKGROUND:

- THE ON-ORBIT TEMPERATURE IS MONITORED BY A SENSOR MOUNTED ON THE AL-HONEYCOMB MOUNTING PLATE. THE COLLECTOR AREA OF THE TWTA IS MOUNTED ON AN AL-HEAT SINK WHICH TRANSFERS THE HEAT PRINCIPALLY BY RADIATION.

CONCLUSION:

- NEITHER THE TEMPERATURE OF THE HEAT SINK NOR THE TEMPERATURE OF THE TWTA COLLECTOR AREA IS MEASURED.

RECOMMENDATION:

- MOUNT A TLM TEMPERATURE SENSOR ONTO THE AL-HEAT SINK FOR DIRECT MEASURE OF THE TWTA COLLECTOR AREA. MEASURE OR CALCULATE THE HEAT DROP BETWEEN TWTA COLLECTOR AND THE SENSOR POINT.

CONFIDENCE

CONCERN:

- PEAK OR BATCH PURCHASE OF TWTA'S MAY BE INEFFICIENT

BACKGROUND:

- TWTA'S FOR SPACE USE ARE NORMALLY ACQUIRED AS PART OF THE S/C OR ARE OBTAINED AS NEEDED AS A LIMITED QUANTITY. NEED OFTEN JUSTIFIES RAPID ACQUISITION

CONCLUSION:

- RELIABILITY AND CONFIDENCE FALL BELOW TWTA PARAMETERS AND NEED DICTATES PRODUCTION RATE

RECOMMENDATION:

- ESTABLISH THE NEXT SAMSO S/C TWTA REQUIREMENT NOW AND BEGIN A MANUFACTURING TECHNOLOGY PROGRAM TO PRODUCE A RELIABLE TWTA WITH SUFFICIENT TIME TO GIVE CONFIDENCE IN THE PRODUCT

TWTA TURN-ON

CONCERN:

- ROOM TEMPERATURE INRUSH CURRENT PEAK VARIES FROM ONE TURN ON TO ANOTHER, AND INRUSH CURRENT PEAK MAY VARY SIGNIFICANTLY WITH TEMPERATURE.

BACKGROUND:

S/N		RM-T	60°F	146°F
24-16	Ip =	9-8 Amp	7	6
24-17		7	5.5	4.4
24-18		9	6	9
24-21		7-8	3	6
24-22		7-9	8	7
24-23		6.5	4.2	9.2.
24-24		8	5	6
14-26		7-8	7	9

CONCLUSION:

- PEAK IN RUSH CURRENT VARIES IN SOME UNKNOWN AND UNPREDICTABLE MANNER.

RECOMMENDATION: CORRELATE INRUSH CURRENT DATA WITH EXPERIMENTAL SET UP AND OTHER PARAMETERS, ESPECIALLY INVESTIGATING TEMPERATURE VARIATION; POSSIBLY USE DATA TO SCREEN INCIPIENT FAILURES.

CATHODE ACTIVITY TEST

CONCERN:

- MEASUREMENT OF TTK IS NECESSARY BUT INSUFFICIENT

BACKGROUND:

- TTK MEASUREMENTS ARE BASED UPON GRAPHICAL METHODS TO DETERMINE THE KNEE OF THE CURVE. THE HELIX CURRENT IS ALSO MEASURED SIMULTANEOUSLY. RIPPLES IN HELIX CURRENT CURVE ARE NOTED WITH SAME TWT AND TWTAs.

CONCLUSION:

- THE GRAPHICAL TECHNIQUE IS INACCURATE AND INCOMPLETE. USEFUL DATA MAY BE AVAILABLE BY FURTHER ANALYSIS OF BOTH THE HELIX CURRENT CURVE AND THE CATHODE CURRENT CURVE.

RECOMMENDATION:

- PERFORM AND RECORD REAL TIME $\partial/\partial t$ OF THE CATHODE CURRENT CURVE. EVALUATE THE RELATIONSHIP OF THE RIPPLES WITH OTHER MEASURABLES. PERFORM INCREASED ANALYSIS ON DATA; PLOT i_K VS i_H, PLOT i_K/t VS i_H/t, ETC.

FFT - CALIBRATION

CONCERN:	●	FFT MAY NOT INDICATE FAILURE PRONE AREAS.
BACKGROUND:	●	FFT OCCURS AT ATMOSPHERIC PRESSURE AFTER 168 HR OPERATION IN VACUUM. TLM CHANNEL CALIBRATION OCCURS AT ATMOSPHERIC PRESSURE.
CONCLUSION:	●	VACUUM ENVIRONMENT AND CALIBRATION MAY BE DIFFERENT THAN IN AIR.
RECOMMENDATION:	●	CALIBRATE TLM AND TWTA IN VACUUM.

INDIUM THERMAL CONDUCTIVITY

CONCERN:

- CONDUCTIVITY ACROSS INDIUM FOIL MAY VARY WITH TIME

BACKGROUND:

- INDIUM OXIDIZES IN AIR AND CAN CREEP, EVEN AFTER MELTED. INDIUM USED AS HEAT SINK INTERFACE WITH OTHER PROGRAMS HAS SHOWN CREEP AND DETACHMENT WHEN APPLIED IN AIR. INCREASED THERMAL RESISTANCE HAS BEEN MEASURED WITH FAULTY BONDS

CONCLUSION:

- THE INDIUM INTERFACE MAY LEAD TO HIGHER TWTA COLLECTOR TEMPERATURES

RECOMMENDATION:

- INVESTIGATE THE INDIUM INTERFACE; INVESTIGATE SUBSTITUTE/ ADDITIVE MATERIAL

TWTA INSTALLATION

CONCERN:

- TWTA STRESS

BACKGROUND:

- TRW REMOVES THE TWTA COLLECTOR AREA MOUNTING SCREWS DURING INSTALLATION OF THE TWTA ONTO THE S/C. RELAXATION AND SUBSEQUENT SCREW TORQUE COULD STRESS THE TWT

CONCLUSION:

- SUBJECT NEEDS INVESTIGATION

RECOMMENDATION:

- ADD ONE OR MORE BASE FLUSH SCREWS TO HOLD COLLECTOR AREA TO TWTA BASE; OR LEAVE HAC ONE SCREW IN PLACE AND TRW MOUNT WITH THREE SCREWS

TWTA INTERFACE OPERATION

CONCERN:

- TLM DATA FROM S/C DURING TESTS WILL NOT INDICATE TRANSCIENTS

BACKGROUND:

- POST INTEGRATION DATA AT TRW IS FROM TLM CHANNELS. TLM SAMPLE RATE IS 1 SEC^{-1} OR GREATER. NO ANALOG DATA IS AVAILABLE.

CONCLUSION:

- ANALOG DATA WOULD BE USEFUL

RECOMMENDATION:

- CONSIDER ADDITION OF ANALOG CHANNELS AT LEAST DURING S/C INTEGRATION TESTS

TWTA CABLING

CONCERN:

- TRW DOES NOT FOLLOW THE MIL-STD WHEN BUILDING THEIR COAXIAL CABLES.

BACKGROUND:

- THE MIL-STD REQUIRES THERMAL CYCLING OF COAXIAL CABLES PRIOR TO INSTALLATION OF CONNECTORS.
- WITHOUT THERMAL CYCLING TEFLON FILLED CABLES CAN COLD FLOW AND CAUSE THE CABLE OR CONNECTOR TO FAIL.
- A SHORTED OR OPEN CABLE CAN INHIBIT PROPER TWTA OPERATION - CAN POSSIBLY CAUSE FAILURE.

CONCLUSION:

- TRW SHOULD VALIDATE THEIR MANUFACTURING PROCEDURE OR USE THE MIL-STD.

RECOMMENDATION: 9/10 AND FUTURE

- ALL TWTA CABLING SHOULD BE REINSPECTED.
- CABLES SHOULD BE SUBJECTED TO AT LEAST 10 THERMAL CYCLES PRIOR TO VSWR TEST AND THEN INSTALLED ON VEHICLE.

PACKAGING

CONCERN:

- THE PRESENT PACKAGING TECHNIQUE MAY RESTRICT COMPONENT TESTING

BACKGROUND:

- SOME OF THE POWER SUPPLY COMPONENTS ARE FABRICATED AND HARD POTTED PRIOR TO ACCEPTANCE TESTING. THE POTTING LIMITS THE TEST SAMPLING POINTS AND DERIVABLE DATA FOR THERMAL-VAC MONITORING VISUAL INSPECTION OF POTTED COMPONENT IS DIFFICULT.

CONCLUSION:

- (ANALOG) SAMPLING OF TEST POINTS MAY BE NECESSARY

RECOMMENDATION:

- MODIFY CONSTRUCTION TO ALLOW SUBASSEMBLY TEST POINT MONITORING DURING THERMAL-VAC. POSSIBLY INCLUDE ON-ORBIT TEST POINT TELEMETRY.

TWTA RF CABLE

CONCERN:

- THERMAL CYCLING OF THE SEMI-RIGID COAX MAY LEAD TO A FAILURE

BACKGROUND:

- THE SEMI-RIGID COAX CABLE BETWEEN THE TWTA AND CIRCULATOR IN THE S/C IS CUT TO FORM AND ATTACHED TO CONNECTORS BY SLIP FIT TO THE CABLE CENTER CONDUCTOR. THE CABLE IS NOT THERMAL CYCLED PRIOR TO ITS INSTALLATION ON THE S/C

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CONCLUSION:

- THERMAL CYCLING ON THE S/C COULD LEAD TO AN RF SHORT OR OPEN CIRCUIT

RECOMMENDATION:

- EVALUATE THE THERMAL CYCLING OF THE SEMI-RIGID COAX AND APPLY AN APPROPRIATE SPEC OF REQUIREMENT

CONCERN: Use of Teflon Insulated Wire In Power Supply

BACKGROUND:
- Previous Ground Test Failure
- Cold Flow on Other Electronic Boxes

RECOMMENDATION: 9/10 None

RECOMMENDATION FUTURE: Discontinue the Use of Teflon Insulator Wire

MIL-W-81044

MIL-W-81381

TWTA RELIABILITY

CONCERN:

- TWTAs UTILIZE UNRELIABLE CONSTRUCTION TECHNIQUES.

BACKGROUND:

- TWTA EPCs USE SEPARATE BOARDS CONNECTED BY WIRE HARNESSES.
- THE BOARDS ARE TIGHTLY PACKED AND BOLTED TOGETHER STRESSING THE HARNESS.
- EFFECTS OF FOLDING ARE NOT ALL OBSERVABLE DUE TO PACKAGING DENSITY.
- MECANICALLY IMPLEMENTATION REQUIRES POTTING OR FOAM TO PROVIDE COMPONENT SUPPORT.
- IT IS EXTREMELY DIFFICULT TO DETERMINE IF UNITS ARE COMPLETELY POTTED OR FOAMED.
- COMPLETE POTTING IS REQUIRED FOR BREAK-DOWN INSULATION IN THE HIGH VOLTAGE MODULE.
- FOAM/POTTING PRECLUDES POSSIBILITY TO VISUALLY INSPECT AFTER TESTING.
- FOAM/POTTING MAKES CHANGES OR REPAIRS DIFFICULT AND UNRELIABLE.
- POTTING INDUCES STRESS BY DISPLACING COMPONENTS.
- POTTING CHANGES CRITICAL PLACEMENT OF FREE HIGH VOLTAGE WIRING.

TWTA RELIABILITY (CONT.)

CONCLUSION:

- THE TWTAs ARE UNRELIABLE IN THAT:
  - ASSEMBLY TECHNIQUES ARE EMPLOYED IN THE EPC WHICH CAUSE STRESS AND DO NOT ALLOW COMPLETE POST ASSEMBLY VISUAL INSPECTION.
  - EFFECTS OF STRESS MAY NOT BE DETECTED BY PRE-LAUNCH TESTING.

RECOMMENDATION: F9/10 - NONE

FUTURE - REQUIRE THAT TWTAs UNDER DEVELOPMENT INCORPORATE CONSTRUCTION TECHNIQUES WHICH ALLOW THOROUGH VISUAL INSPECTION AFTER FINAL ASSEMBLY.

BUS VOLTAGE

CONCERN:

- THE TWTA MAY BE TESTED WITH AN INSUFFICIENT BUS VOLTAGE

BACKGROUND:

- THE S/C BUS VOLTAGE FOR THE TWTA IS 32.2 V-DC NOMINAL. THE TWTA IS TESTED PRIOR TO S/C INSTALLATION AT 28 V-DC

CONCLUSION:

- THE TWTA TESTING IS NOT COMPATIBLE WITH S/C OPERATION

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RECOMMENDATION:

- ALL TWTA TESTS MUST BE COMPATIBLE WITH S/C OPERATION; I.E., V-DC AT 32.2V

TWTA POST LAUNCH TESTING

CONCERN:

- POOR POST LAUNCH TWTA TEST PROCEDURE

BACKGROUND:

- TWTA TELEMETRY DATA IS RECORDED DURING POST LAUNCH TURN-ON.
- THIS DATA INDICATES HOW WELL THE TWTA SURVIVED LAUNCH.
- THE POST LAUNCH TELEMETRY IS NOT PLOTTED OR INSPECTED.

CONCLUSION:

- MOST OF THE AVAILABLE POST LAUNCH TELEMETRY DATA IS NOT UTILIZED TO DETERMINE THE EFFECTS OF LAUNCH OF TWTAs.
- THE STATE-OF-HEALTH OF TWTAs AFTER LAUNCH CAN BE MORE COMPLETELY DETERMINED BY IMPROVING TEST PROCEDURES.

RECOMMENDATION:

- REQUIRE THAT POST LAUNCH TWTA TELEMETRY DATA BE PLOTTED AND COMPARED TO PRE-LAUNCH DATA TO REVEAL ANY CHANGES DUE TO LAUNCH.

TWTA PRE-FLIGHT TESTING

CONCERN:

- INSUFFICIENT PLOTTED TELEMETRY DATA FROM TESTS.

BACKGROUND:

- PLOTTED DATA IS REQUIRED TO OBSERVE ERRATIC PERFORMANCE.
- COMPARISON OF PLOTTED DATA WITH TIME REVEALS PERFORMANCE TRENDS.
- NORMAL PRACTICE NOW IS TO SCAN DATA, BUT NOT PLOT.

CONCLUSION:

- OPPORTUNITIES TO SCREEN POTENTIALLY UNRELIABLE TWTAs ARE LOST BY NOT PLOTTING AND OBSERVING TELEMETRY DATA.
- TEST PROCEDURES NEED TO BE IMPROVED TO SCREEN POTENTIALLY UNRELIABLE TWTA.

RECOMMENDATION: 9/10 AND FUTURE

- REQUIRE THAT TWTA TELEMETRY DATA BE PLOTTED PROMPTLY AFTER EACH TEST AND REVIEWED FOR INDICATIONS OF ERRATIC OR DEGRADING PERFORMANCE.

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TWTA PRE-INTEGRATION TESTING

CONCERN:

- INSUFFICIENT TWTA TESTING PRIOR TO DELIVERY TO SPACECRAFT INTEGRATION.

BACKGROUND:

- TWTAs UNDERGO ONE THERMAL VACUUM CYCLE AFTER FINAL ASSEMBLY PRIOR TO DELIVERY TO SPACECRAFT INTEGRATION.
- DENSE PACKAGING AND USE OF FOAM AND POTTING MAKES SCREENING VIA VISUAL INSPECTION IMPRACTICAL. THIS INCREASES NEED TO DO TESTING AS A SCREEN.
- SOME TWTAs FAIL DURING SPACECRAFT IST AND MUST BE RETURNED TO HUGHES FOR REPAIR.
- ERRATIC BEHAVIOR OF TELEMETRY POINTS IS MORE DIFFICULT TO SPOT WHEN POINTS ARE INFREQUENTLY SAMPLED VIA TLM SYSTEM. BETTER SCREENING SHOULD BE POSSIBLE AT UNIT LEVEL WITH LESS IMPACT ON SCHEDULE AND EXPENSE.

CONCLUSION:

- ACCEPTANCE TESTING SUBASSEMBLIES VIA ONLY ONE TEMPERATURE CYCLE SEEMS NEITHER ADEQUATE NOR PRUDENT.

RECOMMENDATION: 9/10 AND FUTURE

- TEST PROCEDURES SHOULD BE DEFINED WHICH ADEQUATELY WRING-OUT TWTAs PRIOR TO DELIVERY TO SPACECRAFT INTEGRATION.
- THE NEW PROCEDURES SHOULD REQUIRE THE CONTINUOUS RECORDING AND TIMELY EXAMINATION OF ACCEPTANCE

TWTA ACCEPTANCE TESTING

CONCERN:

- TRW NEGATES THE HAC ACCEPTANCE TESTING WHEN THEY MOUNT THE TWTA ON THE SATELLITE PLATFORM.

BACKGROUND:

- HAC BURNS-IN AND ACCEPTANCE TESTS TWTA PACKAGE BEFORE DELIVERY TO TRW.
- WHEN MOUNTING TWTA, TRW DISTURBS THE DELIVERED CONFIGURATION.
- NO TESTS ARE CARRIED OUT BY TRW TO VALIDATE THE TWTA PERFORMANCE OTHER THAN TOTAL SYSTEM TEST.
- THE TWTA PLATFORM SEES ONLY ONE THERMAL CYCLE.
- NO TEMPERATURE MEASUREMENTS ARE CARRIED OUT - COLLECTOR TEMPERATURE UNKNOWN.

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CONCLUSION:

- AFTER REMOUNTING BY TRW THE ACCEPTABILITY (FROM A MECHANICAL AND THERMAL STANDPOINT) OF THE TWTAs IS UNKNOWN.
- SINCE TWTA LIFE IF IMPACTED BY COLLECTOR TEMPERATURE THIS TEMPERATURE MUST BE MEASURED BY TRW AFTER MOUNTING.

RECOMMENDATION: 9/10 AND FUTURE

- ALL TWTA MOUNTS SHOULD BE REINSPECTED FOR MECHANICAL AND THERMAL ACCEPTABILITY.
- THE HEAT SINK TEMPERATURE OF EACH TWTA SHOULD BE REMEASURED. THE COLLECTOR TEMPERATURE SHOULD THEN BE DETERMINED BY ANALYSIS.

TWTA ACCEPTANCE TESTING (CONT.)

RECOMMENDATION: 9/10 AND FUTURE

- ALL FUTURE TWTAs SHOULD BE REDESIGNED SO THAT MOUNTING THE TWTAs WILL NOT REQUIRE DISTURBING THE AS BUILT AND TESTED CONFIGURATION.
- A BETTER METHOD FOR REMOVAL OF TWTAs FROM PLATFORM SHOULD BE FOUND.

TWTA TURN-OFF

CONCERN:

- TWTA MOUNTING ON SATELLITE PLATFORM

BACKGROUND:

- TWTA MOUNTING IS DIFFERENT FROM THAT SPECIFIED TO SUBCONTRACTOR
- TWTA AT IS INVALIDATED BY REMOVAL OF TWT COLLECTOR-END MOUNTING CREWS
- TWTA IS MOUNTED ON NON-PLANAR SURFACE
- COLLECTOR TEMPERATURE HAS NOT BEEN ANALYZED OR MEASURED IN VACUUM WITH CURRENT MOUNTING

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CONCLUSION:

- MECHANICAL OR THERMAL DAMAGE MAY RESULT FROM CURRENT MOUNTING TECHNIQUE

RECOMMENDATION:

- OBTAIN SUBCONTRACTOR'S CONCURRENCE IN CURRENT MOUNTING, BOTH MECHANICAL AND THERMAL
- RE-SPECIFY MOUNTING TO SUBCONTRACTOR IN FUTURE BUYS

TWTA TURN-OFF

CONCERN:

- INPUT CURRENT TO 24-17 DURING FIRST FEW MINUTES AFTER HV TURN-ON NOT CONSISTENT FROM TURN-ON TO TURN-ON DURING TEST.

BACKGROUND:

- VARIABLE SHARPNESS OF CURRENT RISE AND "NOISE" ON INPUT CURRENT OBSERVED IN 24-17 TEST DATA
- B-SIDE TUBE CONSISTENTLY SHARPER RISE AND LESS NOISY
- DIFFERENCE BETWEEN 24-17 AND EC A-SIDE TUBE OBSERVED IN TM FROM ORBIT

CONCLUSION:

- THE 24-17 INPUT CURRENT CHARACTERISTIC FOLLOWING TURN-ON MAY HAVE BEEN AN INDICATION OF AN INCIPIENT FAILURE.

RECOMMENDATION:

- TRY TO ESTABLISH CAUSE OF CURRENT CHARACTERISTIC
- CONSIDER USE OF INPUT CURRENT CHARACTERISTIC AS A TWTA SCREEN

TWTA TURN-OFF

CONCERN:

- UNCOORDINATED ATTEMPTS TO TURN BACK ON AFTER 20 MAY 77 TURN-OFF

BACKGROUND:

- FOLLOWING THE 20 MAY 77 TURN-OFF OF 24-17 ON 9438, THE STC MADE 14 OR 15 ATTEMPTS TO RESTORE OPERATION
- MANY OR ALL OF THESE ATTEMPTS WERE MADE WITHOUT PRIOR COORDINATION WITH CONTRACTOR/SUBCONTRACTOR PERSONNEL

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CONCLUSION:

- IF TURN-OFF WAS RESULT OF HV ARC IN POTTING VOID, EXPERIENCE HAS SHOWN THAT OPERATION MAY BE RESTORED IF TIME IS ALLOWED FOR GAS TO DIFFUSE
- REPEATED ARCS MAY CARBONIZE THE PATH, PREVENTING HV TO BE SUSTAINED THEREAFTER

RECOMMENDATION:

- STC COMMANDING FOLLOWING ANY FAILURE ON A SATELLITE SHOULD BE PRE-COORDINATED WITH APPROPRIATE ORGANIZATIONS, OR SHOULD BE IN ACCORDANCE WITH A PRE-COORDINATED CONTINGENCY PLAN

TWTA TURN-OFF

CONCERN:

- HELIX CURRENT TRIP IN ORBIT

BACKGROUND:

- TWTA'S TRIP OFF AS RESULT OF EXCESS INPUT OR HELIX CURRENTS
- HELIX CURRENT TRIP INTENDED TO PROTECT TUBE AGAINST EXTERNAL PARAMETER CHANGES

CONCLUSION:

- HELIX CURRENT TRIP NOT NEEDED IN ORBIT BECAUSE PARAMETER THAT CAUSES TRIP IS NOT CORRECTABLE AS IT IS ON THE GROUND, SO TUBE OPERATION IS LAST IN ANY EVENT
- HELIX CURRENT TRIP CIRCUITRY IS ITSELF A POTENTIAL FAILURE MECHANISM

RECOMMENDATION:

- IN FUTURE BUYS, MAKE PROVISIONS FOR DISABLING HELIX CURRENT TRIP BEFORE LAUNCH, OR IN ORBIT BY COMMAND

TWTA TURN-OFF

CONCERN:

- POSSIBLE RELATIONSHIP TO RATE OF AIR VENTING FROM TWTA

BACKGROUND:

- VENTING RATE NOT SPECIFIED TO SUBCONTRACTOR AND NOT CONTROLLED

CONCLUSION:

- INADEQUATE VENTING COULD DAMAGE HOUSING, AND/OR CREATE HV ARC ENVIRONMENT IN CONJUNCTION WITH POTTING VOID.

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RECOMMENDATION:

- SPECIFY VENTING RATE IN FUTURE TWTA BUYS

TWTA TURN-OFF

CONCERN:

- "FAILED" TWTA'S MAY STILL BE GOOD

BACKGROUND:

- TWTA'S THAT TURNED OFF IN ORBIT ON OTHER PROGRAMS HAVE BEEN KNOWN TO RECOVER NINE DAYS TO ONE YEAR AFTER TURN-OFF
- RECOVERY BELIEVED RESULT OF CONTINUED GAS DIFFUSION FROM VOID TO BELOW CRITICAL PRESSURE

CONCLUSION:

- 24-17 OR 9438, AND SOME OTHER "FAILED" TWTA'S IN ORBIT MAY BE RECOVERABLE

RECOMMENDATION:

- CONSIDER ATTEMPT AT TURN-ON OF "FAILED" TWTA'S BEFORE ABANDONMENT OR REPLENISHMENT OF SATELLITE
- DEPENDENT UPON OPERATIONAL CONSTRAINTS AND SWITCHING RISKS, TRY TO RESTORE OPERATION OF "FAILED" TWTA'S EVERY FEW MONTHS AFTER TURN-OFF

TWTA TURN-OFF

CONCERN:

- POSSIBILITY OF BEING CAUSED BY HV ARC AS RESULT OF VOID IN TUBE OR PS POTTING

BACKGROUND:

- TURN-OFFS ON OTHER PROGRAMS OCCURRED AFTER 8-16 DAYS IN TV OR AFTER 20 DAYS TO SEVERAL MONTHS IN ORBIT
- LONGEST DSCS II TWTA OPERATION IN TV IS LESS THAN 3½ DAYS
- TWO GROUND OCCURRENCES (ONE TUBE, ONE PS) WERE PROVEN TO BE RESULT OF POTTING VOID WHERE INADEQUATE SURFACE CLEANING PREVENTED ADEQUATE ADHERENCE OF CONFORMAL COST

CONCLUSION:

- IMPROVED PROCESS AND/OR TEST REQUIRED

RECOMMENDATION:

- 30 DAY OPERATING TV OF ALL TWTA'S WITH OCCASIONAL TEMP OR ON/OFF CYCLING TO UNCOVER POOR ADHESIONS AND PROPAGATE VOIDS
- PERHAPS THE TWT BURN-IN CAN BE PERFORMED IN VACUUM TO ACHIEVE MORE VACUUM OPERATING TIME ON THE TUBE

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